DIMENSIONS

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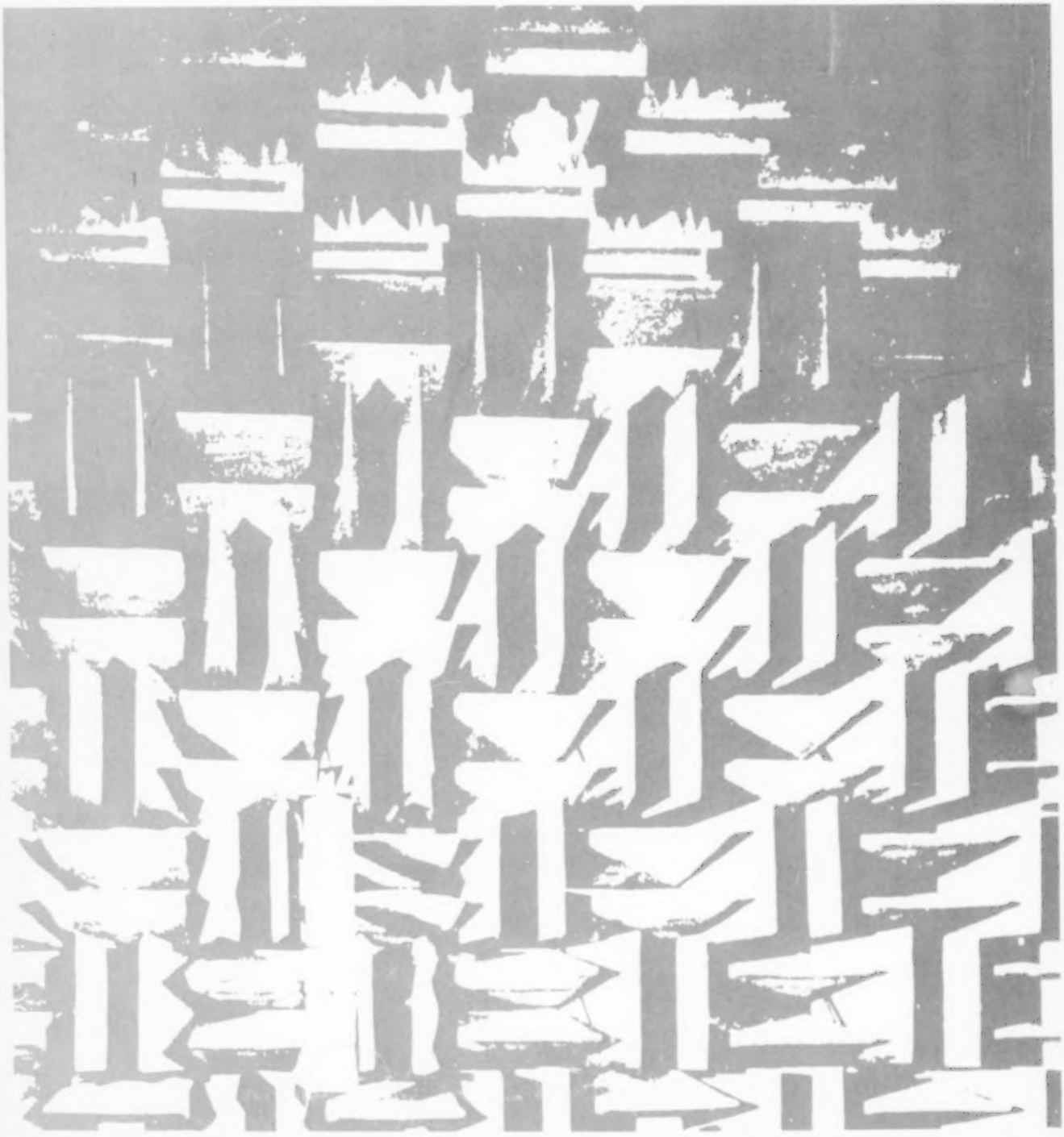
May 1977



STUDYING SOUND. See page 2.

COMMENT

PRIVACY IN MEDICAL RECORDS

How private are medical records that doctors, hospitals, and health insurance companies maintain about each of us? Can we maintain the privacy that *is* deemed necessary? For that matter, do we have the means to maintain accurate medical records and to correct inaccurate information when it is present?

These questions typify people's concern today about their ability to control the collection of information about themselves and to exercise some measure of control over its use. The conflict between people's desires and the record-keeping practices of private organizations and government agencies has been called the Privacy Problem.

Computers have taken much of the blame for the Privacy Problem because they have indeed made it possible for record-keepers to increase the numbers and completeness of their records. It is clear, however, that the fundamental problems of privacy in record keeping were not created by using computers. Instead, the greatly improved record keeping ability afforded us by computers has made the existent problems greatly more conspicuous and irritating. Public policy must be developed that enables us to utilize the benefits of computer technology while preserving individual privacy. The area of technology involved has been given the name computer security.

Even before the Privacy Act of 1974, which requires federal agencies to protect the privacy of personal information both in computerized and manual files, we were working at the National Bureau of Standards to assess and alleviate privacy and security problems in specific computer-dependent activities of our society, such as health care, credit, and personnel record keeping.

We were aware as early as 1970 from the many inputs made to us that there was considerable public concern about the effective and allowable uses of computer technology. Therefore, we contracted with Professor Alan Westin of Columbia University to conduct the first analysis of specific privacy issues in one area of concern. Health care records were the target because a survey made for us showed them to be one of the major areas of public interest, presumably because everyone has health records and because the information they contain is so sensitive.

Beginning in 1973, Professor Westin initiated a two-year research effort to develop independently a set of recommended privacy practices for health-care record keeping. These recommendations are not intended to be a final answer, but rather they are a significant contribution to the dialogue needed to develop meaningful public policy in this important arena.

To insure the credibility and acceptability of Professor Westin's report, a review group drawn principally from the health community was put together. That group, chaired by Dr. Vernon Wilson, former Administrator of the Health Services and Mental Health Administration of DHEW, made significant contributions to the anticipated utility of the report.

I am most pleased to note that the culmination of Professor Westin's study, *Computers, Health Records, and Citizen Rights,* featured in this issue of DIMENSIONS, will not be a passive report. We have already put these recommendations into the hands of the people who have the first line of responsibility for resolving privacy issues—the managers of health care units nationwide.

Professor Westin's study deserves careful consideration by all of us.

Ruth M. Davis

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Director, Institute for
Computer Sciences and Technology

DIMENSIONS/NBS

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UPDATE

Going to EXTREMES in the Study of SOUND

RESEARCH in acoustics—the science of sound—is carried to extremes in a laboratory complex located in a Washington, D.C. suburb. This complex, known as the "Sound Building" is part of the National Bureau of Standards.

There, sound is studied in one chamber designed to absorb at least 99 percent of the sound energy emitted—and it is studied in another room where a whisper echoes on and on. These opposite and extreme environments constitute the major research facilities that support our national measurement system in the area of sound.

The research that goes on in these—and other—NBS laboratories aids a very large community outside the Bureau which depends on NBS measurements methods and standards. For instance, this expertise provides support to those who want to produce reliable sound measuring equipment such as microphones and sound-level meters and to those who must regulate unwanted sound, commonly called noise.

Within the last decade, the nation has awakened to the need to abate noise pollution on a large scale, as recent legislation indicates. But as a subset of sound, noise must first be characterized and monitored. Only then can it be regulated effectively.

Sound at high intensity is very harmful noise, even if exposure is not prolonged. Yet, the acceptability of certain sounds to people in general is not determined solely by intensity. The difference between acceptable sound and noise is dependent on a whole host of psycho-socio-economic factors. The current conflict over the Concorde between the City of New York and the governments of France and the United Kingdom is testimony to that.

The National Bureau of Standards does not resolve this kind of conflict. But it does work to provide the objective, technical base that others use to solve such problems. The goal of NBS in noise abatement is to work with regulatory agencies for a twofold purpose: to assure that actions directed toward the control and abatement of noise can be based on scientifically valid measurement technology and to assure that the required acoustic measurements can be performed reliably, at the needed accuracy and at reasonable cost.

The contingency "at reasonable cost" should not be taken lightly. Research in sound is "taken to extremes" at NBS because poor measurements are expensive, in many ways. Some of those costs are readily apparent—for example, at high sound exposures, measurement uncertainties can lead either to increased hearing loss or to expensive over design of equipment. At intermediate exposure levels, noise interferes with human activities or is an annoyance. Uncertainties in determining exposure to continuing or intermittent noise at these levels may exact financial or social penalties.

Whatever the noise measurement problems, they can be divided into three parts:

1. Measurement of the noise emission for specific sources.
2. Measurement and characterization of the noise environment, and
3. Measurements of the reception of the sound and its effects upon listeners.

NBS scientists have been carrying out research in sound for over seventy years. An unusual application of the anechoic chamber (opposite page) was to conduct a spectrum analysis of rare musical instruments. The Juilliard String Quartet volunteered to participate in last year's experiment.

More commonly, the anechoic chamber is used to determine some of the acoustic characteristics of such devices as hearing aids, sound level meters, and ear protectors.

The places where these measurement problems are confronted by NBS researchers have already been touched on briefly. Specifically, the anechoic chamber and the reverberation room facilitate about 90 percent of the Bureau's research in sound.

Anechoic Chamber

'Anechoic' comes from a Greek word meaning 'without echo'—an understatement of the effect of

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the acoustically 'dead' NBS anechoic chamber. What happens when 99 percent of the sound energy emitted in a room is absorbed? One way to describe it is this: A man shouting in the anechoic chamber would hear about as much of his own voice as he would if he were to shout while falling through mid air.

The eerie quiet of the room is caused by its equally eerie interior design. The chamber is lined with 1.78-meter long wedges of glass wool—on walls, ceiling, and floor. The interior measures 10 x 6.7 x 6.7 meters. Above the floor, a walking surface of steel mesh is suspended, similar in sensation to a very taut trampoline.

The result is an environment where sound sources can be characterized without effects from the 'boundaries'—such as walls that cause echos. In other words, sound propagates outward only; it is not reflected back. Thus, NBS researchers can fully and accurately characterize a sound source, as they have in the case of police sirens, loudspeakers, and reference sound sources used in the design of sound-producing products.

Once a source is characterized, it is possible to introduce a receiver into the chamber and, in the known sound field, characterize or calibrate that receiver. This is done for sound level meters, microphones, hearing aids, and other equipment. Also, sound radiation-pattern experiments are conducted in the anechoic chamber on specific sound sources, as are sound-scattering experiments on well characterized objects, including the human head.

Right. Entrance to NBS Sound Building in Gaithersburg, Md.

Reverberation Room

The NBS reverberation room, on the other hand, is an environment where little sound energy is lost. Highly sound-reflecting surfaces absorb less than 3 percent of the sound energy on each reflection.

The time it takes a sound to die away, called decay or reverberation time, depends on its intensity and frequency (pitch), as well as on the surroundings. So, in the empty NBS reverberation room, a word is a word is a word, dropping in intensity by 60 dB in 1 to 18 seconds, depending on the frequency. For a decay of 60 dB, a sound at 100 Hz takes 15 seconds, at 1000 Hz (2 octaves above middle C) 8 seconds, and at 10 000 Hz the reverberation time is one second.

The fact that sound behaves in this way in the reverberation chamber is the result of its unique construction and controlled environment: It is a vibration-isolated, shell-within-shell structure of massive reinforced concrete construction with inside dimensions of 9.14 x 7.62 x 6.10 meters. A steel plate, double-leaf entrance door provides a clear opening to the room of approximately 2 x 3 meters. Inside is a unique set of adjustable, variable-speed, rotating vanes to improve the diffusion of the sound field. The interior of the chamber and the surrounding one-meter-wide air envelope are air conditioned and humidity-controlled.

Researchers can use the reverberation room to determine the total power of a sound source, based on knowledge of the reverberation time, the room, and the sound level created in the room. The noise emission characteristics of appliances, business and small industrial machines, and other equipment have been determined in this way.

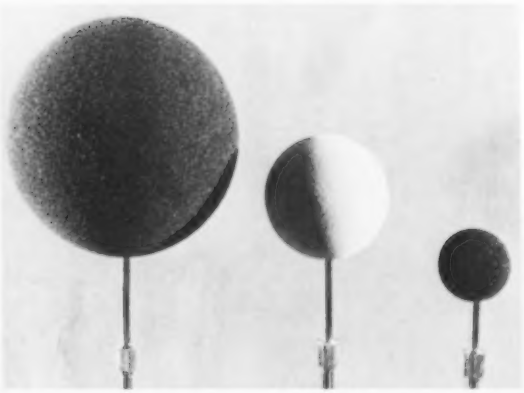
Obviously, although they are opposite acoustic environments, the reverberation and anechoic chambers have some parallel uses. But there are also very different applications. For instance, reverberation time can be used to measure the sound absorption of a material such as acoustical tile.

Laboratory for Psychoacoustics

NBS has added a special laboratory to the facilities of the Sound Building for the study of psychoacoustics—human response to sound.

Unlike the anechoic and reverberation chambers, the psychoacoustic laboratory looks quite commonplace—for a living room. Here, researchers study the effects of sound on volunteer subjects in a "realistic" setting.

However "realistic" the living room may seem,



it is still an acoustic laboratory. Walls are plaster-bonded directly to dense cinderblock. The floor is wood parquet over a cement slab. The "ceiling"—actually, an opaque set of suspended panels that are acoustically transparent (that is, permeable by sound)—conceals a bank of hidden loudspeakers and a real ceiling that is acoustically hard (impermeable by sound). The furniture is low-profile, with exposed surfaces of artificial leather and hard wood to reflect sound. Drapes and throw rugs are placed and proportioned to allow for variable control of the reverberation time. The windows are double glazed and the doors are specially constructed for acoustic isolation.

Putting Expertise to Use

Obviously, NBS facilities for studying sound are versatile. And research is not limited to the laboratory. Data may be gathered at a construction site, for instance, or on a highway. The 'experimental subject' may be a microphone or a volunteer. But one question remains: how effective is NBS in seeing that research results are put to use?

NBS transfers technology through a number of mechanisms, including the development of voluntary standards and direct contact with regulatory agencies such as the Environmental Protection Agency, the Department of Transportation, and the Occupational Safety and Health Administration.

NBS is also involved in technology transfer at the community level: Authorities seeking to regulate noise at commercial/residential boundaries, for example, often run into unforeseen complications with sound measurement equipment. To solve such difficulties, NBS has held workshops for enforcement officials in cooperation with the Office of Noise Abatement and Control of the Environmental Pro-

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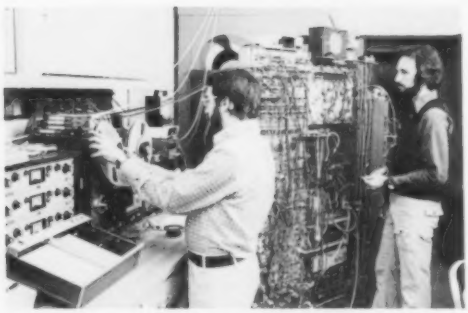
Left. The acoustic absorption of a fiberglass architectural ceiling tile is determined in the NBS reverberation room. The structurally damped aluminum vanes rotate at 7.5 rpm during the test to increase the diffuseness of the sound field. Center. Open-celled polyurethane foam encases microphones used for measurements taken out-of-doors. This casing screens the microphone from interference from wind turbulence. The devices are tested in both the anechoic and reverberation rooms. Right. Wind-screened microphones are used to measure truck-tire noise.

Top. NBS mobile acoustic instrumentation van used for field measurements. Center. Instrumentation inside the van, including computer and real-time 1/3-octave band frequency analyzer. Bottom left. The sound field distribution around a subject is studied in the new laboratory living room. Right. Living room is shown prior to installation of acoustically transparent ceiling. Bottom. Shown here is some of the instrumentation used in testing a subject's response to well characterized sounds.



tection Agency. These workshops concern measurement errors associated with the use of sound level meters and microphones. Attendees are made aware of errors such as these caused by wind, temperature, humidity, and ground cover, and they are instructed on how to obtain consistent and repeatable noise data.

On the Bureau's own doorstep, Montgomery County, Maryland, put a noise control ordinance into effect after considerable advance preparation with assistance from NBS and other experts.

As millions of people are examined annually for hearing loss, the examiners base diagnostic evaluations on readings from audiometers whose accuracy and validity are ultimately "traceable to the National Bureau of Standards."

To protect the hearing of very young Americans, a limit on "impulsive noise" was included in a recent Voluntary Product Standard for Toy Safety, processed by the Bureau. Equipment, procedures and test methods for making the determination are specified in the standard.

Broadening the Scope

To further broaden the scope and relevance of NBS noise research, the Bureau's Center for Building Technology is developing a "library" of household noises. This tape-recorded library promises new insight into the indoor noise problem, particularly acute today because of modern building trends toward light-weight materials, prefabricated systems and open space planning. The library's data base should help in the formulation of improved criteria for use in building standards, codes, and regulations.

Careful planning and careful research are intended to make NBS programs in noise and acoustics responsive to national needs. The final emphasis is on delivering the technology to potential users. The aim is maximum public benefit. □

RECENT NOISE LAWS, REGULATIONS

1968

- Federal Aviation Act amendment concerns abatement of aircraft noise and sonic boom.

1969

- Regulations are adopted under Walsh-Healey Public Contracts Act to set noise exposure limits for 27 million workers.
- National Environmental Policy Act requires federal agencies to submit environmental impact statements on any proposed actions significantly affecting environmental quality, with attention to noise as well as other forms of pollution.
- Bureau of Public Roads takes on noise control as one of its assigned functions under a new policy and procedures memorandum.

1970

- The Secretary of Transportation, under a new amendment to the Federal Highway Act, is directed to move against adverse environmental effects of highway development and to promulgate highway noise control standards compatible with different land uses.
- Noise Pollution Abatement Act becomes first legislation providing a central focus to environmental noise abatement for the nation. The act sets up, within the Environmental Protection Agency, an Office of Noise Abatement and Control.

1971

- Occupational Safety and Health Act calls for protection against noise for some 55 million employees of firms in interstate commerce. Bureau of Mines adopts same noise limits for mining industry workers.

1972

- Consumer Product Safety Act creates independent regulatory commission to deal with dangers in products, including excessive noise.
- Noise Control Act sets a national policy to provide for all Americans an environment free from noise that jeopardizes their health and welfare.


THINGS YOUR MOTHER NEVER TOLD YOU ABOUT SPINACH!
SPINACH
King Features Syndicate, Inc. 1977
DIMENSIONS / NBS

by Madeleine Jacobs

EVER wonder why spinach is supposed to be so good for you? Popeye will tell you it's the presence of healthy quantities of iron. But did you know that every gram of spinach also contains manganese, strontium, zinc, uranium, and europium—in fact, at least 27 trace elements?

Uranium and europium? That's right—tiny, tiny amounts to be sure, but they're there all the same. This news comes from scientists at the National Bureau of Standards who have developed a "standard spinach" in which the concentrations of 27 trace elements have been carefully determined.

The standard, technically called Standard Reference Material for Trace Elements in Spinach, was developed for the Food and Drug Administration. FDA is using it to calibrate instruments that test for toxic substances present in minute quantities in fruits and vegetables. These tests are conducted regularly at FDA field stations across the nation in sample "market basket" surveys of fruits and vegetables. Based on the results, produce containing too much of the toxic elements is barred from the marketplace.

Of trace elements present in foods, a number have been identified as essential to good nutrition—such as iron, copper, chromium, cobalt, and zinc. Still others have been identified as harmful contaminants. Arsenic, mercury, lead, and uranium fall into this category. The role of most other trace elements such as strontium, rubidium, and manganese has yet to be determined.

In recent years, questions have been raised about contamination of fruits and vegetables grown near sources of urban pollution. Spinach, lettuce, and other leafy vegetables grown near highways are reported to acquire potentially harmful metals that are difficult to remove by washing.

To determine whether foodstuffs are contaminated, scientists must painstakingly analyze thousands of samples of food grown at various locations in both clean and polluted environments. The NBS standard spinach is used as a reference to assure accurate analyses.

To make the standard, NBS used more than 9 metric tons of commercially-grown spinach. The spinach was freeze-dried to a weight of 585 kilograms, ground, blended, homogenized, and carefully analyzed using nine of the most complex and

sophisticated analytical methods available. Nearly two dozen scientists in the NBS Institute for Materials Research were involved in developing the Standard Reference Material.

It took 18 months to complete the standard, which is the second botanical standard that NBS has developed for trace-element analysis. The first was orchard leaves. Standards for tomato leaves and pine needles are also available.

So, the next time someone tells you to eat your spinach, you can tell them what's in it. Here's the complete list of 27 elements: potassium, calcium, phosphorus, aluminum, iron, manganese, strontium, zinc, rubidium, copper, chromium, lead, arsenic, thorium, uranium, mercury, nitrogen, bromine, boron, nickel, cadmium, cobalt, lanthanum, scandium, antimony, thallium, and europium. And, of course, spinach also contains the basic building blocks present in all organic substances—hydrogen, carbon, and oxygen.

Bon Appetit! □

Liquefied Natural Gas:

Moving Energy from here . . .

by Kent Higgins

LAST winter was the season for natural gas to make front page headlines. As the worst recorded cold spell in the nation's history swept the southern and eastern United States, one state after another found that dwindling supplies of natural gas brought on emergency conditions. Schools, factories, and businesses closed, and cities adopted fuel-saving provisions of almost wartime severity.

Increasing prices and decreasing supplies of fuel of all kinds have made Americans more conscious than ever before of energy. Congressmen, scientists, and private associations are taking a closer look at what we as a nation can do to meet our needs. And though solar, geothermal, and particularly nuclear power have significant potential, their contributions to the energy supply today are insignificant when compared to our energy demands.

Natural gas, on the other hand, is a resource of the present. It is the basic fuel of 30 percent of the nation. Natural gas is one of the cleanest and cheapest fuels available. In terms of energy self-sufficiency, it is one of the most reliable options. In 1976, the U.S. produced about 566 billion cubic meters of natural gas and imported only about 30 billion cubic meters. Ninety-seven percent of the supply was used for fuel.

In addition, there is an established distribution system for natural gas, a network of 9.6 million kilometers of pipeline criss-crossing the nation. But sometimes, as we discovered last winter, the distribution system doesn't work as well as it should.

Higgins is a program information specialist at NBS Boulder Laboratories.

Liquefied Natural Gas

To have the necessary amount of natural gas in

the right place at the right time is a complex problem with political, economic, and technical facets. To help solve the technical side of the problem, a group of scientists at the National Bureau of Standards in Boulder, Colorado, have been developing and improving methods for getting natural gas from producer to consumer in a liquefied form called LNG.

LNG is important to the whole natural gas system because of the economics of transportation and storage. When natural gas is converted to LNG, it occupies 1/600 of its original volume, and of course the heating energy is 600 times greater for the same volume of LNG versus natural gas. A major factor is the obvious advantage of transporting natural gas as LNG by ship to and from foreign countries where pipelines are not feasible or are impractical to construct.

Distributors contract every year for a specified amount of natural gas that they in turn supply to their customers on a daily basis. Climate conditions often cause a heavy use of heating or cooling units which demand more gas than the distributor can supply. This is a *peak-demand condition.*

One way to reduce the effect of peak-demand conditions is to build LNG *peak-shaving facilities,* where distributors convert natural gas that is unused during times of low demand to LNG. The LNG is stored until peak-demand conditions arise. Then, when the daily allotment is consumed, the unused natural gas, stored as LNG, is converted back to natural gas and provided to the distributor's customers with no interruption. Without peak-shaving facilities, gas distributors are faced with the predicament of paying higher prices for more gas or telling some customers that their gas supply is being cut off until the demand decreases.

Today, peak-shaving facilities account for the largest use of LNG in the U.S. One hundred-six facilities are now in operation or being completed, (55 are actual liquefaction, storage, and gasification operations; 51 are satellite storage plants). Existing U.S. peak-shaving plants can now store 3 million cubic meters of LNG (65 billion cubic feet equivalent of natural gas) and produce approximately 14,000 cubic meters of LNG daily for storage.

LNG Imports

An Energy Resources Council report recommended in 1976 that the projected annual LNG imports to the U.S. be limited to from 37.8 to 47.2 million cubic meters (0.8 to 1 trillion cubic feet equivalent of natural gas) from a single country,

. . . to there

with an overall national import level of 94.4 million cubic meters of LNG (2 trillion cubic feet equivalent of natural gas). The American Gas Association (AGA) estimates 34 billion cubic meters (1.3 trillion cubic feet) of natural gas could be produced annually in Alaska by the early 1980's. One proposed plan is to "import" the Alaskan natural gas as LNG, rather than construct a gas pipeline which would extend through Alaska and western Canada to the U.S. If the Alaskan gas is converted to LNG and combined with the imported LNG, our nation's annual supply can be boosted 15 percent, a thousand-fold increase over the LNG imported in 1972.

The interstate transfer of LNG in the U.S. is minimal at this time. Peak-shaving plants are only storing their own natural gas as LNG until needed. Currently, the buyer/seller (custody transfer) exchange of the LNG is uncommon in the U.S. When LNG is transported by massive tanker ships, a custody trans-

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fer of each cargo occurs. A few of these ships are now completed and 16 are currently under construction for U.S. companies. Most LNG tankers will carry a 125,000 cubic meter cargo of LNG—each shipload the equivalent of over $3 million in natural gas at today's prices.

One can see that the manufacture, transportation, and distribution of LNG is both a national and international concern. In fact, the U.S. is presently a net exporter of LNG from Alaska to Japan due to contracts signed in 1968.

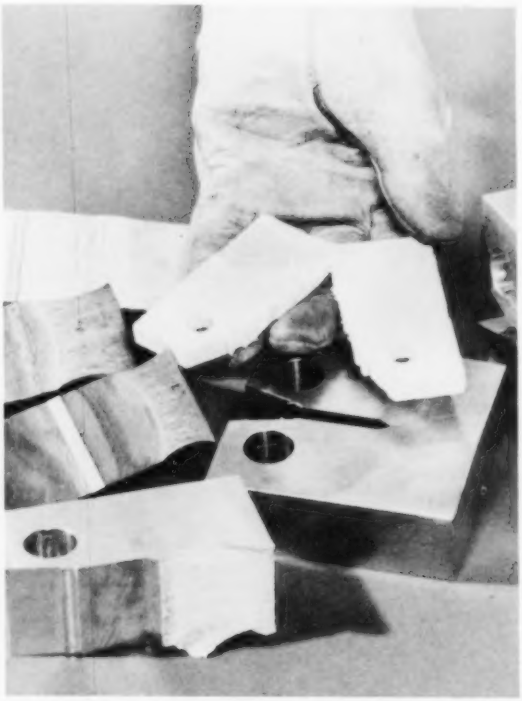
NBS Research

The cryogenic temperature of LNG, −162 °C, causes unique measurement problems that affect the shipping, storage, and trading of the fluid. As the nation's central laboratory for cryogenic research, the NBS Cryogenics Division has concentrated on three major areas affecting LNG. These are defining the thermophysical properties of the pure gas components and the mixtures that make up LNG, as well as predicting the density of LNG mixtures; improving the accuracy with which LNG is bought and sold by studying volumetric and mass flow meters, and developing a three-part "therm meter" to determine the heat output of a LNG mixture; and ensuring the reliability of the materials used to contain and handle LNG at extremely low temperatures.

The basic technology to liquefy and store gases has existed for years. By the second half of the nineteenth century, James Prescott Joule and William Thomson (Lord Kelvin) knew certain gases could be liquefied. They devised a method of cooling gases to liquids by performing the task of compressing, removing the resulting heat, and then allowing the gas to expand resulting in cooling, over and over until the temperature was low enough for the gas to liquefy. This technique has been called the Joule-Thomson effect.

In 1893, Sir James Dewar demonstrated a vacuum vessel, called the Dewar flask, which he used for storing liquefied gases at their low temperatures. In 1914, Godfrey Cabot patented a LNG liquefaction method and a plant was constructed. Indeed, the liquefaction and storage techniques developed by Joule, Thomson and Dewar are still very common today in the field of cryogenic research.

Depending on its source, natural gas is 80 to 99 percent methane. Other gaseous components may include heavier hydrocarbons, carbon monoxide, sulfur compounds, and inert gases. Generally, each natural gas source differs in density and heat output due to different specific weights and heating values of the gases mixed with methane. To be equitable, natural gas suppliers must constantly adjust the composition of their dispensed gas. A standard heat output (38.5 megajoules per cubic meter or 1035 Btu's (British thermal units) per cubic foot) is maintained by evaluating the supply gas with combustion calorimeter.



Metals used in LNG transportation and storage facilities have been evaluated for their strength and durability at the −162 °C temperature of LNG.

Thermophysical properties data of methane and ethane have been completed. Published data for methane from triple point conditions to temperatures above ambient at pressures to at least 34 500 kPa (5000 psi) include: the thermophysical properties; dielectric constant and polarizability; velocity of sound; specific heat; refractive index; and viscosity and thermal conductivity equations.

NBS research has acquired the following data for ethane: melting pressures, orthobaric liquid densities, PVT (Pressure-Volume-Temperature) properties, specific heats, acoustic properties, and derived thermodynamic properties.

In addition, a comprehensive equation of state

for the thermodynamic properties of fluids has been published.

Another NBS project area is concerned with prediction of LNG densities, at or near saturation as a function of pressure, temperature, and mixture composition. The technique involves precision measurements of pure fluid (i.e. methane) and binary mixture (i.e. methane-propane) densities throughout a temperature range of 140 K to 110 K –133 to –163 °C.) The correlation methods are then evaluated by comparing calculated densities with precise density measurements for selected multicomponent (i.e. methane-ethane-propane-n-butane) and LNG type mixtures. The project is close to completion.

Measuring The Flow

Since 1968, NBS has acquired and published extensive data on the performance of volumetric and mass flow devices commonly used for industrial cryogenic fluids. More than 60 meters, based on five different generic types, have been tested under controlled laboratory conditions and in the field. A model code developed by NBS and the Compressed Gas Association, was adopted by the 61st National Conference on Weights and Measures for approval as a permanent code.

Although the code and recommended practices specifically exclude LNG (because industrial cryogenic fluids such as hydrogen, oxygen, argon, and nitrogen are better characterized than LNG mixtures), the LNG industry will be able to apply the model code results to the custody transfer of limited amounts of LNG dispensed from road trailer operations.

The use of larger pipe diameters of 60 to 90 cm has necessitated the development and evaluation of large scale flow meters for LNG. NBS is presently defining the scaling laws for flow meters increased to 10 and 20 cm. Water and liquid nitrogen flow calibration facilities at NBS have been used for LNG and gas flow meters where applicable.

The placement of 10- and 20-cm diameter flow meters in a working flow circuit line at a New Jersey peak-shaving facility indicate preliminary agreement of ±1.5 percent. Additional plans in this program call for the selection of a large capacity LNG facility for the installation and testing of meters greater than 40 cm in diameter.

NBS is also developing a novel 3 element measurement system for predicting the gross heating value of LNG flowing in a pipe line. Called a *therm meter,* the instrument includes a volumetric flowmeter, a direct reading densitometer, and a combustion calorimeter that is compatible with current industrial calorimeters.

The therm meter will measure the volumetric flow (cubic meters per hour) and combine this with the measured density (kilograms per cubic meter) to get mass flow rate. The combustion calorimeter provides a measure of heating capacity in joules per kilogram, and the two figures taken together give the required measurement of joules per hour.

Presently, LNG deliveries from ship to foreign shores (or vice versa) cannot be measured with accuracies better than ±3 to 10 percent. These inaccuracies are expected to be refined to within 1 percent by the current NBS research.

By the time LNG is received in large quantities at U.S. terminals, NBS research is expected to have refined these measurements to accuracies approaching ±0.5 percent. If this accuracy is attained, the custody exchange net loss or gain for each ship load will be under $20,000, a far cry from today's possible $100,000 or more exchange error.

Metals For LNG

NBS input has already aided industry in the design and manufacture of LNG liquefaction, storage and loading/unloading terminal facilities and tanker ships. Stainless steels (304, 310 and 316), aluminum alloys (3003, 5083, and 6051), nickel alloyed steels (3.5, 5, 7 and 9 percent), and Invar (iron and 36 percent nickel) are metals used in pipelines, storage tanks and tanker ships. They have been tested by NBS for their strength and durability at the –162 °C temperature of LNG. This year several types of commercial and natural insulations will be evaluated and their capabilities determined for use with the very cold LNG. This work is critical if LNG is to be stored for any length of time, such as in tanker ships and coastal storage facilities. Indeed, if heat can penetrate the storage walls and warm the LNG, the liquid will begin to expand and vaporize, causing a potential safety hazard. Safety activities by NBS have involved the basic thermophysical characteristics of LNG's component gases. Generally, it has been found LNG is no more dangerous than gasoline or natural gas in similar situations.

By the start of the 1980's, LNG should be a common commodity in the U.S. thanks in part to research assistance provided by the National Bureau of Standards. With this energy boost from LNG, our nation will have gained a few precious years for research and development of other energy sources. □

NBS Issues Landmark Study

PRIVACY in Health Records

by Madeleine Jacobs

THE Los Angeles County Medical Center is a large county facility, primarily serving the urban poor and minority groups of East Los Angeles. With four hospitals, the center admits more than 90,000 patients a year and has 850,000 outpatients. In the early 1970's, the Center began a project to computerize medical records in a data bank to improve patient care. For example, among the benefits of the computer is an alert system which flags a warning of a pre-existing condition every time a patient's medical record is called up. If a patient is a diabetic, for instance, a code appears on the admission form that places the patient in a special ward.

However, under pressure to recover costs from as many people as possible, the Los Angeles facility has had to demand extensive personal information from patients. All patients or their legal guardians must sign a general consent form before treatment begins. This allows the hospital to release medical information to the patient's insurer and to other institutions or agencies accepting the patient for medical or institutional care. In addition, government and law enforcement officials seeking patient data have relatively easy access to the information, either without the patient's knowledge and consent or with the pro forma consent to which the patient must agree in order to receive medical treatment. As a result, the benefits of the computer in improving patient care have been partially offset by the patient's loss of privacy, confidentiality, and informed consent.

Jacobs is a writer and public information specialist in the NBS Office of Information Activities.

Study looks at the role of the computer in privacy and recommends safeguards for protecting citizen rights

ACROSS the continent in New York City is the Dr. Martin Luther King, Jr. Health Center a federally funded, private facility providing care in a high poverty area of the South Bronx. It supplies comprehensive family center care to about 40,000 registered patients. In 1971, the King Health Center moved to a computer system to cope with the increasing burden of paper work and to provide better patient care. One result of the computer system was a profile generated monthly on each patient who had a transaction the previous month. This is attached to each patient's folder and serves to update billings, flag routine treatments, remind physicians about drug sensitivities and print out a problem oriented table of contents to aid chart review. Today, the center has computer applications for registration, appointments, laboratory testing, billing, patient visits, payroll, personnel, and other management functions.

But unlike the Los Angeles County Medical Center, the Martin Luther King, Jr. Health Center places great emphasis on privacy and confidentiality of patient information. Patients rights handbooks inform all patients that no personal records are released to outside doctors, health facilities, or other agencies without the written consent of the patient. The staff receives special training in protecting citizen rights. The Center has also worked especially hard to see that its efforts to insure confidentiality are not compromised by efforts to build regional computerized data systems. As a result, the Center is considered by many experts to be an outstanding pioneer in its definition and application of patient's rights, demonstrating that both advanced technology and respect for privacy can coexist.

TODAY, virtually every hospital in the United States has computerized some aspects of its operations—from billing to the ability to maintain complete medical data on an individual from birth to death. As the two examples illustrate, not all hospitals that have employed the computer to maintain records more efficiently and to improve patient care have gone about it in the same way, or with the same results. The cases illustrate an increasing problem in many areas of record keeping—the conflict between people's desire for privacy and the need of private organizations and government agencies to collect and use data for legitimate needs. The advent of the computer has complicated the situation by enabling record keepers to maintain more numerous and detailed files.

In an effort to study this problem, the National Bureau of Standard's Institute for Computer Sciences and Technology sponsored the first indepth investigation of computerized record-keeping practices and citizen-rights rules in health organizations. The two-year study, recently published as *Computers, Health Records, and Citizen Rights*, assessed current record-keeping practices in health-care organizations, described the role of computers, and recommended a set of technical requirements for computer security in this area.

ICST Director Dr. Ruth M. Davis explains that the study was undertaken by NBS as part of its responsibilities to advance the effective use of computer technology in federal record keeping. However, she notes that the study is applicable to private organizations as well.

turn page

"We focused our study on health-care data because everyone has health records maintained about them and because the information they contain is so sensitive," she says. As the first of its kind, the NBS study is also intended to serve as a model for studying privacy safeguards in other record-keeping areas such as personnel*, banking and finance, credit bureaus, education, welfare, and law enforcement and criminal justice.

The concept of the model study was an outgrowth of a workshop on privacy held in 1973 under the auspices of ICST and the Association for Computing Machinery.

"The workshop attendees thought it would be valuable to study one important area of record-keeping about people that was undergoing significant computerization," Davis recalls. "The study would identify the standards needed in that area if society is to realize benefits from information technology without jeopardizing fundamental citizen rights."

ICST contracted with Alan F. Westin, a professor of public law and government at Columbia University and a noted privacy expert. Under Westin's direction, a small interdisciplinary team of researchers began the project in the summer of 1974. They examined literature from the fields of medicine and health, law, computing, and the social sciences. They also held numerous interviews with major computer manufacturers; systems developers; and civil liberties, public interest, consumer, and minority-rights groups. The team conducted on-site visits to six representative health-care organizations that used computers to handle personal records, and they corresponded with 70 organizations in the health-care field.

As a baseline for studying the impact of computer-use in health care, the report describes three different "zones" (see diagram) in which individual health data are used, each with different social norms and legal rules as to rights of privacy, confidentiality, and individual access. In Zone 1, primary health care, the report describes how medical records are used when a patient seeks help from a health professional, whether in a physician's office, a clinic or hospital, or in the health unit of an institution. Zone 2 covers use of medical data for payment of services and quality-of-care reviews. For the 190 million Americans whose bills are paid, in part, by private insurance coverage or government medical programs, the legitimate need for payers to determine eligibility, assess claims, and detect fraud has created a system in which reports of sensitive diagnoses and conditions are obtainable from primary health-care records. In Zone 3, social uses of health data, the report details how American society has come to require the disclosure of personal health data to serve a wide range of other important interests, from employment, life insurance, welfare, and rehabilitation to law enforcement, social research, licensing, and prevention of child abuse.

During the study of these zones, Professor Westin found that an "individual's medical and health data now circulate from doctors' offices, clinics, and hospitals to the files of insurance companies, health-care review committees, employers, educational institutions, the military, the police, credit bureaus, government licensing agencies, groups conducting research studies and surveys, and a host of other users.

"Our study found rising criticism of the use of health data in many of these areas to make stigmatizing and discriminatory judgments about people," explains Westin. The report cites examples of leaks of confidentiality and misuse of health data about people who have had psychiatric care, homosexuals, women who have had abortions, and persons who want to keep confidential the fact that they are undergoing drug or alcohol rehabilitation.

A particularly dramatic example is the case of a woman who was diagnosed as a schizophrenic, was given shock treatments at a hospital, and allowed to go back to work. Because her condition was fragile, she wasn't told the actual diagnosis. But the hospital sent a report to her insurance company, which sent a report to her employer. Back at work, she found that her coworkers knew all about her illness. The woman became paranoid and stopped treatment.

"What we have to realize is that the issue of privacy in health records affects the life of each of us," Westin says. "Every time we visit a hospital or fill out a health-insurance form, a record is generated and the information regularly flows out of the primary health-care setting in ways that give us very little control."

After examining how medical records are now kept and used, Westin's team looked at the use of computers in six organizations involved in auto-

*NBS and the Federal Privacy Protection Study Commission are currently sponsoring a study on personnel record-keeping practices.

CODE OF CITIZEN-RIGHTS PRACTICES FOR HEALTH-DATA SYSTEMS*

1. Health-Data Systems Should Be Created, Significantly Altered, and Periodically Audited Through Public Rather Than Closed Procedures.

   Health-data systems should be created by public notice and privacy-impact procedures, communicated to any population of known individuals about whom records are to be kept, and reviewed by an independent authority. Major expansions, and tests of the system's adherence to rules, should also be reviewed periodically by outside authority.

2. Every Health-Data System Should Observe Limits of Relevance and Social Propriety In What Personal and Medical Information It Collects or Records.

   Such limits will depend not only on what each data system really needs to carry out a mission approved by society,but also on how effectively, by law and practice, an organization handles the particularly sensitive health information it seeks to record.

3. Every Health-Data System Should Promulgate Clear Rules and Procedures That Insure Citizen Rights.

   These include advance notice to individuals of the uses that will be made of their personal information; a right to obtain full information about the contents of their health records and to inspect such records if they desire; information-release forms that specify what is to be released, to whom, and for what period of time; and patient's rights handbooks and representatives for all health-care facilities.

4. Health-Data System Managers Should Take Special Measures To Protect The Accuracy and Security Of The Data They Keep.

   Personal data should be kept accurate, timely, and complete, measured by the kinds of uses that are being made of it. Staffs should be trained in citizen-rights principles and procedures, and data-security measures should be taken in accordance with the history of data threats in that organization's experience.

5. Managers Should Follow Special Procedures To Allow Medical Research, Health-Care Evaluation, and Public Oversight Without Impairing Citizen Rights.

   Such procedures include using records in statistical or coded forms for most review or research purposes, having protective committees screen requests for access to data when informed consent of the individual cannot be obtained, and using random audit rather than individualized review procedures in order to avoid invading privacy rights.

* This code incorporates the twelve principles contained in the final chapter of *Computers, Health Records, and Citizen Rights,* published by the National Bureau of Standards.

mating personal health records: the Los Angeles County Medical Center; the Dr. Martin Luther King, Jr., Health Center in New York City; the Kaiser Permanente Medical Care Program in San Francisco and Oakland, California; the U.S. Indian Health Service in Tucson, Arizona; the Multi-State Information System in Orangeburg, New York; and Mutual of Omaha in Nebraska.

As a result of this investigation, it was found that although computers are being used increasingly in health care organizations, most instances of actual

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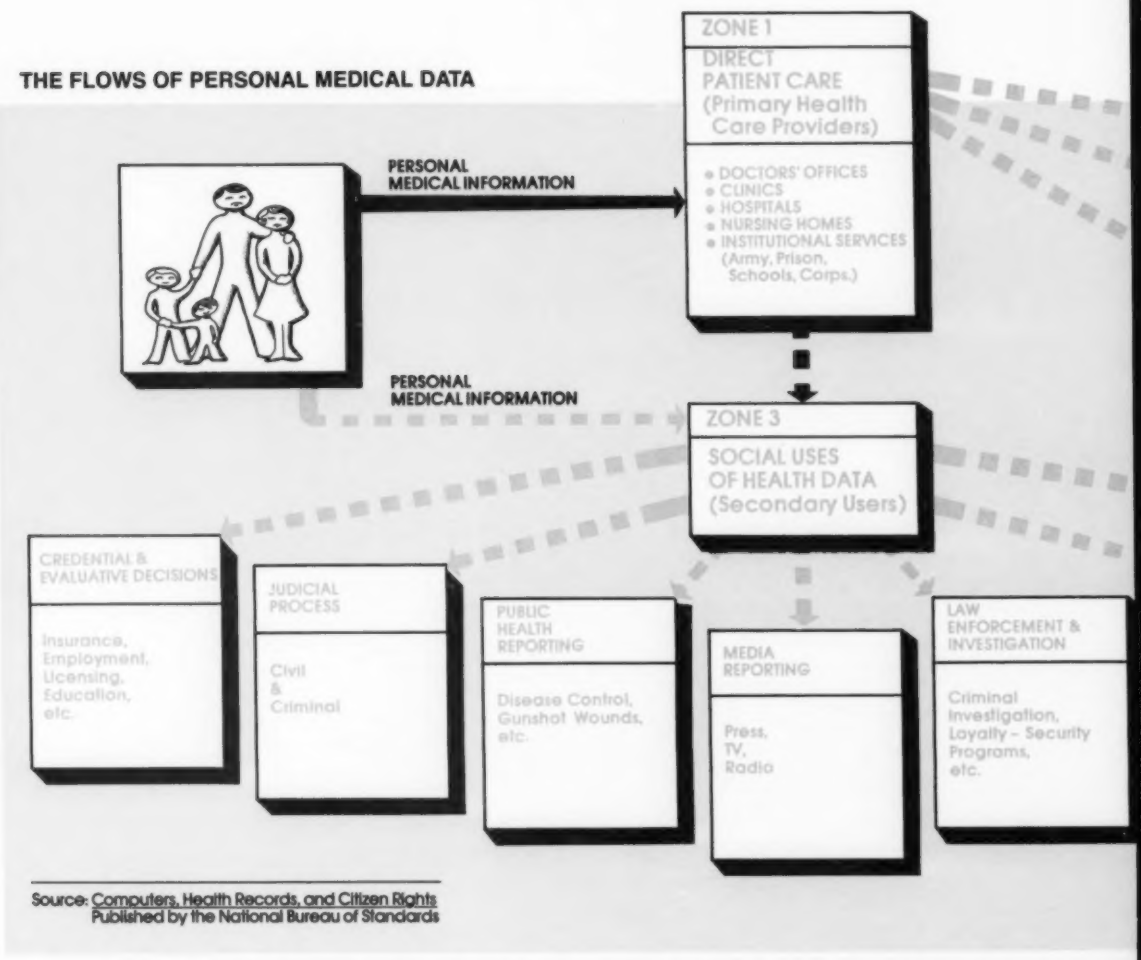
THE FLOWS OF PERSONAL MEDICAL DATA



Source: Computers, Health Records, and Citizen Rights
Published by the National Bureau of Standards

abuse of health information involve manual records.

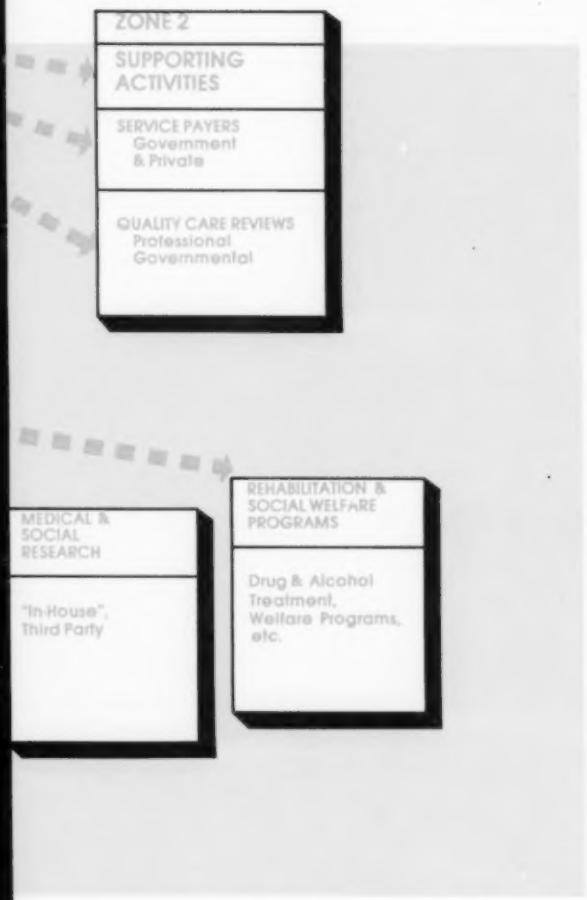
"These remain the places where most sensitive medical data records and health data are stored and through which transfers of data are still carried out," Westin says. "In fact, we found that as a whole, computerized health records are more securely kept and processed today than manual records." Westin points out that instances of leakage or misuse cited in the report almost always took place in manual files. The main problem today with use of automated medical records involves the potential for harm, the study states.

Commenting on the widely held misconception of "the computer as villain," NBS' Ruth Davis says, "Computers have taken much of the blame for the privacy problem because they have indeed made it possible for record keepers to be much more efficient. It is clear from the study, however, that the fundamental problems of privacy in record keeping were not created by using computers. Computers have simply made the existing problem more conspicuous and irritating."

The report shows optimism by stating that there is still time to satisfy the concerns over citizen rights at the blueprint stage of hospital information systems. This can avoid the need for remedial measures.

Westin believes that "no single action can hope to deal with the tremendously varied and complex issues of citizen rights in health record keeping. It will take a mosaic of policy decisions over time to do what is needed. But we must begin now. We cannot afford to wait until national health insurance is enacted or the reorganization of the American health-care systems is completed."

Westin proposes that one of the most fundamental actions is to guarantee people the right to know what information is in their health records, a right



over which there is much controversy in the medical community.

"People should be able to obtain full information about the contents of their health records and to inspect such records, if they desire," he says. "They should also have the right to specify what information is to be released, to whom, and for what period of time."

In addition to these recommendations, the study states that managers of health-data systems should accept primary responsibility for protecting the accuracy and security of data in their systems. These managers must develop and follow special procedures to limit the amount of information needed by a data system to perform its function and to prevent unauthorized access to information.

The report also goes into the special responsibility of computer professionals in the protection of citizen rights in health care. It notes that when any government data systems are being considered in local communities or at the state level, informed computer professionals can do a great deal to help concerned public interest groups understand how such proposed systems will work, or how existing systems are working.

In all, the study recommends a set of principles (see box) that should be followed in the management of health-data systems in order to protect privacy. "These make up a code of citizen rights practices for health-data systems and standards of practice in computerized record keeping," Westin states. "In addition, the study pinpoints those issues that are ripe for legislative and judicial action. What we're talking about is a whole new approach to handling health data."

Davis points out that "public policy must be developed that enables us to utilize the benefits of computer technology while preserving individual privacy. The recommendations are not intended to be a final answer, but rather a significant contribution to the dialogue needed to develop meaningful public policy in this important area."

In keeping with this objective, NBS has sent the study to the Federal Privacy Protection Study Commission, which has primary responsibility for developing such public policy. Established by an act of Congress in 1974 to investigate the entire privacy issue, PPSC plans to report to Congress later this year and recommend legislation for safeguarding the privacy of records in many areas, including health care.

"We did not want this report to be a passive one," adds Davis, "and it was also important to us to put these recommendations directly into the hands of the people who have the first line of responsibility for resolving privacy issues—the managers of health care units." As a result of this concern, Davis notes that NBS has distributed a condensed version* of the 401-page report to nearly 10,000 administrators of hospitals and of local, state, and federal agencies concerned with health care. □

*The full report, *Computers, Health Records, and Citizen Rights*, NBS Monograph 157, is available from the Superintendent of Documents for $4.55 a copy, $5.66 for foreign mailing. Use SD Catalog No. C13.44:157 when ordering. The condensation, *A Policy Analysis of Citizen Rights Issues in Health-Data Systems*, NBS Special Publication 469, is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The price is $1.05 per copy, $1.30 for foreign mailing. Use SD Catalog No. C13.10:469.

RESOURCE CONSERVATION AND RECOVERY

by Madeleine Jacobs

Every year 126 million metric tons of municipal solid are discarded, most of it in landfills or open dumps. Such dumping can contaminate drinking water from underground and surface supplies and pollute the air and land. But in addition to creating environmental and health hazards, discarding municipal waste is an expensive proposition—$1.1 billion a year. Tremendously valuable resources are also lost in the process—nearly 9 thousand metric tons of tin, 10.8 million metric tons of ferrous metals and 1.1 million metric tons of aluminum.

As a result of the Resource Conservation and Recovery Act of 1976, the National Bureau of Standards is now actively involved in helping the country increase the rate of resource recovery of materials and energy from municipal waste. The major goals of the law are to protect the health and environment through environmentally acceptable disposal and better use of discarded materials.

Under the law, the Department of Commerce, acting through NBS and in cooperation with national standards-setting organizations, will "publish guidelines for developing specifications for the different classes of materials to be recovered from waste." NBS' Harvey Yakowitz explains, "These materials include ferrous and nonferrous metals, glass, and refuse-derived fuels among others. The guidelines will contain information on the chemical and physical properties of the materials needed in order to demonstrate comparable performance of recycled materials with virgin materials."

Yakowitz is in charge of carrying out NBS responsibilities in resource conservation and recovery. "Our role will be to define what information the specifications must contain, but standards organizations will develop the actual specifications," he continues. In developing the guidelines, which must be completed by October 21, 1978, Yakowitz has been in close touch with industry representatives as well as with other government agencies with waste management responsibilities and the American Society for Testing and Materials.

"This program directly affects many industries, including those that are producing recovery technology and those which utilize recovered products," he says. "One of the concerned groups is the National Association of Recycling Industries, an organization of companies involved in the $2 billion a year secondary materials processing industry. Another major industry group is the $5 billion resource recovery industry, that develops and builds the technology and plants needed for recycling."

Electric power utilities are also involved because of their interest in refuse-derived fuel as a supplement to fossil fuels. "They have been cooperating with us to help us understand what characteristics refuse-derived fuel must have in order to be useful to them for burning," Yakowitz says.

Refuse-derived fuel (RDF) is a major area of emphasis in the NBS program. RDF is obtained from the organic fraction of municipal waste, making up 80 percent of solid waste and responsible for major pollution problems. Says Yakowitz, "If we could reclaim all the organic fraction as refuse-derived fuel, we could supply 2 percent of current U.S. energy needs. Refuse-derived fuel can take many forms however—fluff, char, oil, pelletized refined solid, and gas—and there are no accepted specifications for any of these forms."

As a consequence, NBS scientists have begun investigating what properties of RDF must be specified. These properties include heat, moisture, and ash content, corrosion characteristics, emission characteristics, and storability.

"Specifications, which are somewhat analogous to performance standards, are vitally important for recycled materials," Yakowitz declares, "because they will dictate the type of resource recovery technology that will be selected for a specific product and will also affect the marketability of the recovered product."

To elaborate, he cites the example of recycled aluminum. "The content of magnesium and copper in recovered aluminum can seriously affect the properties of aluminum and thus the price of the product. Our guidelines will state that the amounts and kinds of metals present in recovered aluminum should be clearly defined in specifications."

Ultimately, it is intended that the development of such guidelines for specifications will inform proprietors of resource recovery facilities of the steps they need to take in order to provide saleable energy and materials. It will also inform users of recycled materials that the raw materials they will purchase can meet a given requirement. And, lastly, it will help provide information to both sellers and buyers—including the federal government, which will be required to procure recycled goods whenever possible.

STANDARDS FOR LAW ENFORCEMENT

by J. J. Diamond

Several years ago the President's Commission on Law Enforcement and Administration of Justice conducted a study and found the following: Military and aerospace technology were having an interesting effect on the law enforcement community. Spinoffs from these and other areas were flooding the market with new equipment. But unfortunately, law enforcement officials generally lacked the technical background to evaluate this equipment. Consequently, they were more or less at the mercy of equipment salesmen. The problems created by this situation were, of course, numerous.

In their report, the President's Commission recommended that "A federal agency should be assigned to coordinate the establishment of standards for equipment to be used by criminal justice agencies, and to provide those agencies technical assistance," and stated that "The National Bureau of Standards is one such agency." NBS and the Department of Justice's Law Enforcement Assistance Administration acted on this recommendation and established the Law Enforcement Standards Laboratory (LESL) in 1971 to work directly with the administration's National Institute of Law Enforcement and Criminal Justice.

The partnership works like this: The institute, with LESL concurrence, establishes priorities for the kinds of equipment that will be investigated, based on the needs of the law enforcement community. LESL's technical staff and consultants review the equipment and make a preliminary determination of the performance attributes to be considered. The equipment is then subjected to intensive laboratory study. After reviewing the test data and the users' needs, a standard is prepared that defines performance requirements based on the state of the art and the equipment's intended use. In addition to the required levels of performance, the standards include the test methods to be used to evaluate this performance. I have listed here the standards that LESL has completed thus far. These are the major end products of our work, but they are not our only outputs.

Technical reports are published as a project progresses. These range from state-of-the-art surveys to detailed discussions of technical matters such as newly developed test methods. Guideline documents are also produced. Written in layman's language, they discuss the equipment's principles of operation, the considerations involved in its selection, installation, and use, and problems that may be expected during the equipment's lifetime.

How does our work get to the potential user? The main mechanism is through the National Institute of Law Enforcement and Criminal Justice. The Institute issues our standards as voluntary standards and makes them available to the law enforcement community. Procurement officers can then include the standards in purchasing contracts. In some cases, we interact directly with the user community. For example, LESL has compiled a reference collection of automotive paints that NBS sells to forensic science laboratories. This collection is used to help identify—from a small paint sample—the make and model of a "suspect" vehicle.

Other federal agencies also make use of our services. The standards we have developed for the National Highway Traffic Safety Administration, for example, are mandatory standards. NHTSA uses them in its own testing laboratory to test products for compliance. Those that comply are placed on qualified products lists which are published in the Federal Register.

I recently received indications that a new delivery system of considerable magnitude for LESL standards may be developing. The Department of Defense has requested the General Services Administration to develop a new GSA supply catalog of civilian law enforcement equipment based on the LESL standards. Products would be tested for compliance with the standards before being entered in the catalog. Many agencies would benefit from such a listing, including the FBI, the Secret Service, the Customs Service, and the National Park Service.

For more information on LESL activities, contact me by writing Physics B150, National Bureau of Standards, Wash. D.C. 20234, or phone 301/921-3167.

Diamond is chief of the NBS Law Enforcement Standards Laboratory.

LESL STANDARDS

(Single copies of the standards may be obtained free of charge from the National Criminal Justice Reference Service, U.S. Department of Justice, Washington, D.C. 20531.)

NILECJ-STD-0101.00, March 1972. Ballistic Resistance of Police Body Armor
NILECJ-STD-0102.00, March 1973. Hearing Protectors for Use on Firing Ranges
NILECJ-STD-0104.00, May 1974. Portable Ballistic Shields
NILECJ-STD-0104.00, October 1974. Riot Helmets
NILECJ-STD-0105.00, June 1975. Crash Helmets
NILECJ-STD-0106.00, September 1975. Ballistic Helmets
NILECJ-STD-0201.00, September 1974. Fixed and Base Station FM Transmitters
NILECJ-STD-0202.00, October 1974. Mobile FM Transmitters
NILECJ-STD-0203.00, October 1974, Personal/Portable FM Transmitters
NILECJ-STD-0202.00, October 1974. Mobile FM Transmitters
NILECJ-STD-0203.00, October 1974. Personal/Portable FM Transmitters
NILECJ-STD-0204.00, December 1976. Fixed and Base Station Antennas (in press)
NILECJ-STD-0205.00, May 1974. Mobile Antennas
NILECJ-STD-0206.00, September 1975. Fixed and Base Station FM Receivers
NILECJ-STD-0207.00, June 1975. Mobile FM Receivers
NILECJ-STD-0208.00, October 1975. Personal/Portable FM Receivers
NILECJ-STD-0211.00, June 1975. Batteries for Personal/Portable Transceivers
NILECJ-STD-0212.00, September 1975. RF Coaxial Cable Assemblies for Mobile Transceivers
NILECJ-STD-0213.00, December 1976. FM Repeater Systems (in press)
NILECJ-STD-0301.00, March 1974. Magnetic Switches for Burglar Alarm Systems
NILECJ-STD-0302.00, May 1974. Mechanically Actuated Switches for Burglar Alarm Systems
NILECJ-STD-0303.00, May 1974. Mercury Switches for Burglar Alarm Systems
NILECJ-STD-0304.00, June 1975. Passive, First Generation Night Vision Devices
NILECJ-STD-0305.00, June 1975. Active Night Vision Devices
NILECJ-STD-0306.00, May 1976. Physical Security of Door Assemblies and Components
NILECJ-STD-0308.00, March 1977. Sound Sensing Units for Intrusion Alarm Systems
NILECJ-STD-0601.00, June 1974. Walk-Through Metal Detectors for Use in Weapons Detection
NILECJ-STD-0602.00, October 1974. Hand-held Metal Detectors for Use in Weapons Detection
NILECJ-STD-0603.00, June 1975. X-Ray Systems for Bomb Disarmament
NILECJ-STD-0604.00, February 1976. Chemical Spot Test Kits for Preliminary Identification of Drugs of Abuse (in press)
*38FR30459, November 1973. Evidential Breath Testers for Alcohol Testers
*40FR36167, August 1975. Calibrating Units for Breath Alcohol Testers

* Printed in the Federal Register. Single copies may be obtained from the Law Enforcement Standards Laboratory, National Bureau of Standards, Washington, D.C. 20234.

STAFF REPORTS

MEASUREMENTS OF EARTH'S MOTION AGREE WITH GENERAL RELATIVITY THEORY

Scientists have obtained and analyzed earth-moon distance measurements and found no evidence of a postulated gravitational effect which would violate a basic principle of Einstein's general theory of relativity. The predicted effect is a difference between the earth's gravitational and inertial mass; the experiment finds these quantities equal within 1.5 parts in 100 billion.

This experimental validation of Einstein's principle took place under a program called the Lunar Ranging Experiment (LURE). The experiment was conducted by members of nine institutions, including the University of Texas McDonald Observatory, the Jet Propulsion Laboratory, Princeton University, and the University of Maryland. NBS participated in the design of the retroreflector placed by astronauts on the moon's surface, in obtaining the first returned signals, and in analyzing the data. Beams of light were "fired" at the moon and reflected back to the earth from the retroreflector. This allowed researchers to develop highly precise and accurate measurements of the earth-moon distance calculated on the time it takes light to make a "roundtrip" to the moon.

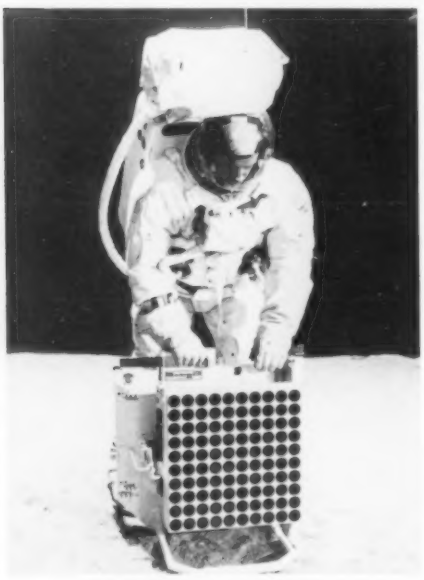
The lunar ranging program, proposed by U.S. scientists in 1965, is still underway and now involves groups in several countries. The data being gathered are relevant to research in physics, lunar science, and geophysics.

James E. Faller Quantum Physics Division, Joint Institute for Laboratory Astrophysics (JILA) Boulder, Colo., 303/499-1000.

Einstein based his general theory of relativity on the equivalence of a gravitational field and an accelerated reference frame (the equivalence principle). This is another way of saying that the gravitational and inertial definitions of mass are equivalent, a statement which accounts for the observation that masses of unequal size and composition fall at the same rate. For hundreds of years scientists have tested the principle of equivalence in the laboratory. Within the limits of experiment, the principle has always been vindicated.

In 1961, R. H. Dicke (Princeton University) suggested that a body's gravitational self-energy might contribute unequally to the body's gravitational and inertial mass, and thus violate the equivalence principle. However, all past experiments to measure a difference between gravitational and inertial mass have employed laboratory masses which are not large enough to show a dependence on gravitational self-energy. Then in 1968, K. Nordtvedt, Jr. (Montana State University) independently discussed the self-energy question and developed a theoretical basis for studying it and estimating the possible magnitude of its possible effects. To check his ideas he suggested several possible experiments, one of which was the accurate measurement of the earth-moon distance. Not only is the earth large enough to show the Nordtvedt effect, but the resulting anomalous gravitational force on the earth would slightly alter its orbit around the sun. The moon has a much smaller gravitational self-energy relative to its mass, and thus its solar orbit would be almost unchanged. The consequence of these different behaviors would be tell-tale irregularities in the earth-moon distance.

The laser ranging method measures the earth-moon distance with an uncertainty of about 15 centimeters, sufficient to reveal the estimated 10-meter deviation in the moon's earth-centered orbit if the maximum possible self-energy effect were present. To search for such an effect, the LURE team calculated the lunar orbit from equations including perturbations from all nine planets and from known relativistic effects. They then compared calculated earth-moon distances with 1523 earth-moon range measurements made from August 1969 to May 1975. If a self-energy term had been present in the measured distances, it would have shown up as a monthly (29.5-day) variation in the differences between the two sets of data. No such variation was found. Given this null result and the present accuracy of



A technician demonstrates how retroreflector panels are set up on the moon. Each black circle contains a fused-silica corner cube, which reflects light back along its incoming direction. Laser light pulses aimed at a reflector on the lunar surface are thus returned directly to their source on earth. The Apollo 11 and 14 flights carried arrays of 100 cubes similar to the one in this simulation. However, scientists have obtained most of the lunar-range data using an array of 300 cubes set up by the Apollo 15 crew.

lunar ranging and orbit analysis, the LURE scientists concluded that the gravitational self-energy contributions to the earth's gravitational and inertial mass are equal to within ±3%. An equivalent statement is that the earth's ratio of gravitational to inertial mass differs from unity by no more than 1.5×10^{-11}. These conclusions are supported by an independent analysis of the same data by scientists at the Massachusetts Institute of Technology and the Air Force Geophysics Laboratory.

The McDonald Observatory of the University of Texas made all the range measurements which were used. Pulses of ruby laser light, of wavelength 694.3 nanometers and about three billionths of a second long, were fired at the moon and then reflected back by retroreflectors which Apollo astronauts placed on the moon. The measured quantity is the round trip travel time of each laser pulse, from which the LURE researchers compute the earth-moon distance.

Over the next several years, improvements in lunar range measurements and their analysis are expected to increase the sensitivity of the equivalence-principle test by a factor of ten. The McDonald Observatory will be joined in the LURE observing program by the University of Hawaii's new lunar ranging station on Maui, where range measurements will have an uncertainty of only ±3 centimeters. This station, under the direction of Dr. Solomon Cushman, will employ a laser with a pulse length of 0.2 billionths of a second, as well as other specialized equipment for the job. The receiving telescope is a new, multilensed instrument that will hold its gaze on a lunar reflector by means of a computer-controlled tracking system.* The telescope will extend range measurements (further into the period of low lunar contrast (new moon) when observations must be made during daylight hours.

* The telescope was designed and built under the direction of Dr. Faller. A "Staff Report" in an upcoming issue of DIMENSIONS/NBS will discuss the design and planned application of this new device.—ed.

LIMITS OF HYDROGEN LIQUEFIER EFFICIENCY DEFINED

NBS played a vital role in developing hydrogen technology for the space age and improving this technology for the commercial use of hydrogen fuel. Hydrogen is a clear contender for the synthetic fuel market and a prime candidate to satisfy many long-term national fuel requirements. An economic barrier to the early adoption of liquid hydrogen as a synthetic fuel is the cost of producing liquid hydrogen from gaseous hydrogen.

Current economic data indicate hydrogen appears attractive as an aircraft and aerospace fuel and in certain integrated gas-electric utility systems (producing hydrogen for storage of solar or off-peak electrical energy). Application as a fuel for auto transportation and electrical utility systems currently appears economically marginal.

Although hydrogen as a fuel is not currently cost-competitive with most alternate fuels, increased efficiencies of production, liquefaction, and energy conversion may drastically change today's cost comparisons, as will the increases in fossil-fuel prices and more stringent environmental constraints.

Researchers have developed a method for calculating a maximum possible efficiency for hydrogen liquefiers as a function of component efficiency. The method permits calculation of a maximum efficiency for current liquefiers and estimates efficiencies for future liquefiers utilizing higher efficiency components.

Roland O. Voth, Cryogenics Division, Room 2-1112, Boulder, Colo., 303/499-1000, x-3632, and David E. Daney, Cryogenics Division, Room 2-1114, Boulder, Colo., 303/499-1000, x-3695.

In an effort to enhance the understanding of hydrogen liquefaction, we have developed a method for calculating a maximum possible efficiency for liquefiers as

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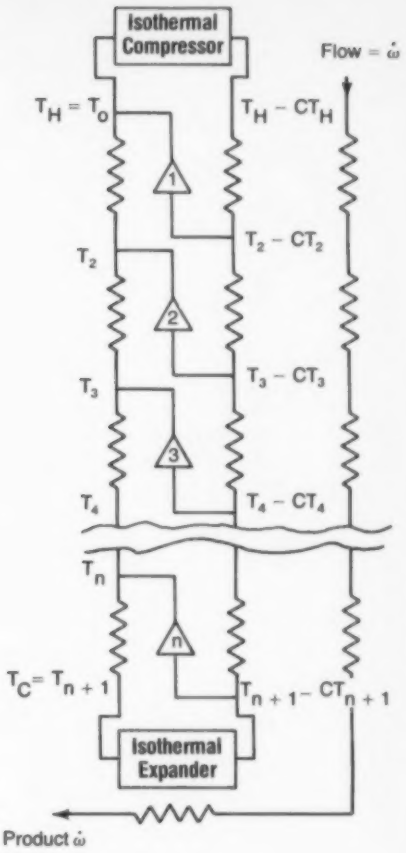


Figure 1—Schematic Of The Defined Cycle. *Derivation of the defined cycles: The cycle uses a refrigeration loop to precool and condense a separate product stream. The refrigeration loop bypass turbines are situated so the inlet temperature of each expander is higher than the discharge temperature of the preceding expander by the temperature difference of the heat exchanger. The heat exchanger temperature differnce is proportional to the absolute temperature as defined by a constant $C = \triangle T/T$. The final expander in the refrigeration loop is an isothermal expander used to condense the product stream. Both the refrigerant and the product streams are perfect gases with constant specific heats. The product stream condenses at T_c with a latent heat 28.988 K times the specific heat (i.e. the same ratio as for hydrogen). Changing the latent heat ratio and the value of T_c would make the defined cycle applicable to other fluids. The high temperature (heat rejection) end of the cycle (T_H) is taken as 300 K in the calculations, while the cold end temperature (T_c) was taken as 20.268 K, the normal boiling point of liquid parahydrogen.*

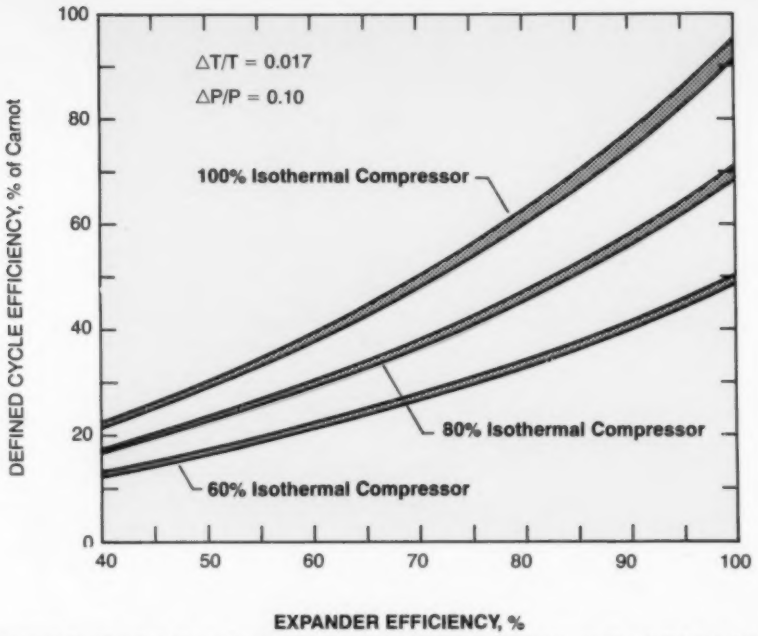
The arrangement of the expanders in the precooling portion of the cycle is the most efficient arrangement because the refrigeration required by the product stream is exactly matched at each temperature by the refrigeration produced by the expanders. For reversible expanders and heat exchangers, this arrangement is reversible. For finite size heat exchangers, balanced flow maintains a constant heat exchanger temperature difference, and the flow through each expander is the same as the product stream flow, $\dot{\omega}$. In order to maintain $\triangle T \sim T$ in the heat exchanger (which minimizes the heat exchanger losses), a slight imbalance in the flow is required, resulting in a slightly greater expander flow.

a function of component efficiency. Losses due to pressure drop and heat exchange temperature differences are also included in the analysis. Using the results, a maximum efficiency for current liquefiers can be calculated and the possible increase in efficiency for future liquefiers utilizing higher efficiency components can be estimated.

The usual approach to liquefier cycle studies is to make a parametric study of many cycles, using a computer, and then to choose one of the calculated cycles that is compatible with available components. Although this approach gives exact results, one is never quite sure that a different (and unconsidered) cycle might not yield a superior efficiency. By using a simple defined cycle which is reversible for reversible components, we are able to easily evaluate the effect of various system components, and to make a reasonably accurate estimate of the maximum possible cycle efficiency with components of given efficiencies.

We used a defined cycle to determine whether the efficiency of existing hydrogen liquefiers could be increased. The results from the defined cycle indicate that with a 60 percent efficient isothermal compressor, 80 percent adiabatic precooling expanders, and an 80 percent isothermal expander, the maximum liquefier efficiency attainable is 40 percent (figure 2). Losses due to system pressure drops and heat exchanger temperature differences reduce the defined cycle efficiency to 34 percent (figure 3) and 30 percent (figure 4). A reasonable efficiency for a practical liquefier may lie somewhere between 30 and 34 percent efficiency without considering other losses such as heat leak to the cold components or probable irreversibilities resulting from the properties of a real gas. One would expect that an efficiency of 30 percent may be the practical limit for liquefiers using state-of-the-art components.

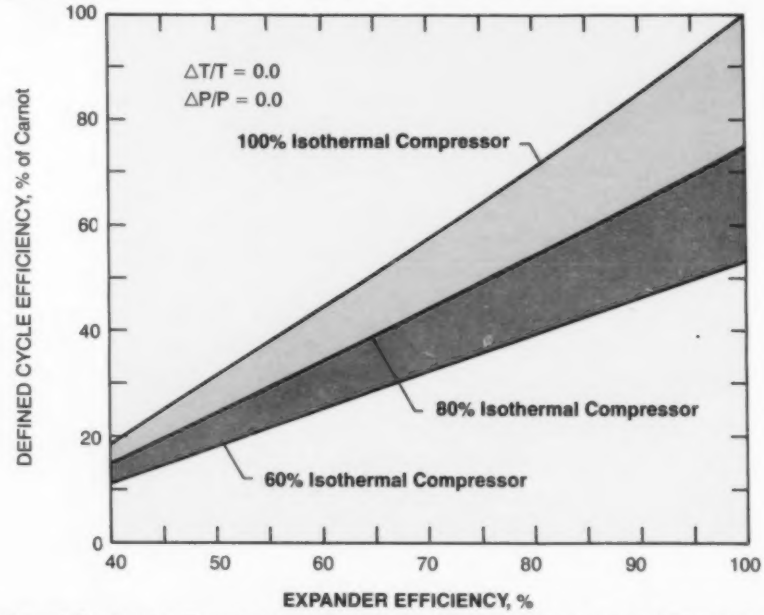
Based on this analysis, the currently reported efficiencies of about 30 percent for large industrial hydrogen liquefiers show good design and optimization.



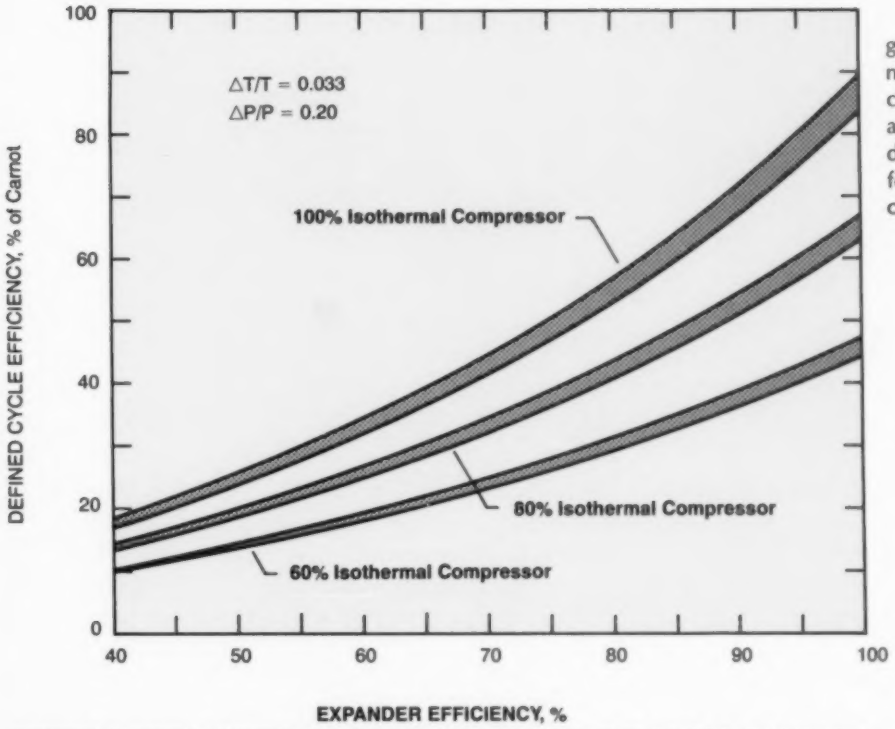
Isothermal Condensing Expander has the same Numerical Efficiency as the Adiabatic Precooling Expanders

Figure 2—Defined Cycle Efficiency Without Pressure Drop and Heat Exchanger Temperature Difference Losses. *Cycle efficiencies as a function of expander and compressor efficiencies are shown in this figure. The precooling expanders and the isothermal expander were assumed to have the same numerical efficiency. The plotted results are for a liquefier with six precooling expanders. The results show that without considering any losses from heat exchanger temperautre differences or pressure drop, the maximum cycle efficiency obtainable with 80 percent of adiabatic precooling expanders, an 80 percent isothermal expander, and a 60 percent isothermal compressor is approximately 40 percent of Carnot.*

Figures 3 and 4—Defined Cycle Efficiency Including Losses From Pressure Drop and Heat Exchanger Temperature Differences. *These figures show the final results of the cycle efficiency analysis. All losses are included in the plots with the double line denoting the maximum and minimum pressure drop effect. The cycle efficiency varied with the number of expanders, and if the maximum efficiency occurred with less than six expanders that point was plotted; otherwise the cycle efficiency for six precooling expanders was plotted.*



Isothermal Condensing Expander has the same Numerical Efficiency as the Adiabatic Precooling Expanders



Isothermal Condensing Expander has the same Numerical Efficiency as the Adiabatic Precooling Expanders

Our defined cycle should serve as a guide to engineers performing thermodynamic cycle studies to improve the efficiency of liquefiers (the defined cycle is applicable to all fluids), and it should help define the maximum attainable efficiency for future liquefiers when higher efficiency components become available.

NBS MICROCOPY RESOLUTION TEST CHART SRM ACCEPTED FOR INTERNATIONAL USE

American industry and Government spend millions of dollars annually to microfilm records and preserve films. To assure that the microfilmed images are of adequate quality to store the required information, microfilm contracts generally stipulate that the resolving power of the complete microfilming system be evaluated by means of an NBS microcopy resolution test chart. Such charts have been issued by NBS for about 26 years, as part of the Bureau's Standard Reference Materials (SRM) program.

This SRM, designated SRM 1010a, Microcopy Resolution Test Chart, has recently been used as the basis for an International Organization for Standardization (ISO) standard.

William R. Smallwood, Optical Physics Division, B223, Metrology Building, 301/921-2157.

Issued as ISO 3334, "Microcopying-ISO Test Chart No. 2—Description and use in photographic documentary reproduction," this standard was approved by 24 of 25 member bodies of the International Organization for Standardization.

The introduction of this standard states: "This International Standard is based on a widely used method employing the U.S.A. National Bureau of Standards Microcopy Resolution Test Chart. This method has found wide acceptance by users of microcopying techniques, and the arrangement of test patterns is identical with the NBS 1963-A Chart. It is intended for use with International Standards concerned with microcopying."

NBS began issuing the "1963-A" chart as SRM 1010a in December 1967, as a replacement for SRM 1010, which was designed in 1963. Although the new ISO standard states that the charts must bear the legend "ISO Test Chart No. 2," all NBS microcopy resolution test charts, regardless of date of issue, satisfy the requirements of all U.S. Government specifications for microfilming services.

The design of the charts and the quality control is the responsibility of the NBS Optical Physics Division. Originally produced by NBS, the charts now are prepared commercially, but they are still issued by the Bureau with the same quality control that was exercised when NBS was the producer.

A typical plant can save about 20 percent of its fuel—just by installing waste heat recovery equipment. But with so much equipment on the market, how do you decide what's right for you?

Find the answers to your problems in the *Waste Heat Management Guidebook*, a new handbook from the Commerce Department's National Bureau of Standards and the Federal Energy Administration.

The *Waste Heat Management Guidebook* is designed to help you, the cost-conscious engineer or manager, learn how to capture and recycle heat that is normally lost to the environment during industrial and commercial processes.

The heart of the guidebook is 14 case studies of companies that have recently installed waste heat recovery systems and profited. One of these applications may be right for you, but even if it doesn't fit exactly, you'll find helpful approaches to solving many waste heat recovery problems.

In addition to case studies, the guidebook contains information on:

- sources and uses of waste heat
- determining waste heat requirements
- economics of waste heat recovery
- commercial options in waste heat recovery equipment
- instrumentation
- engineering data for waste heat recovery
- assistance for designing and installing waste heat systems

To order your copy of the *Waste Heat Management Guidebook*, send $2.75 per copy (check or money order) to Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. A discount of 25 percent is given on orders of 100 copies or more mailed to one address.

The *Waste Heat Management Guidebook* is part of the EPIC industrial energy management program aimed at helping industry and commerce adjust to the increased cost and shortage of energy.

U.S. DEPARTMENT OF COMMERCE/National Bureau of Standards
FEDERAL ENERGY ADMINISTRATION/Energy Conservation and Environment

POLYETHYLENE PROPOSED FOR BIOCOMPATIBILITY STUDIES

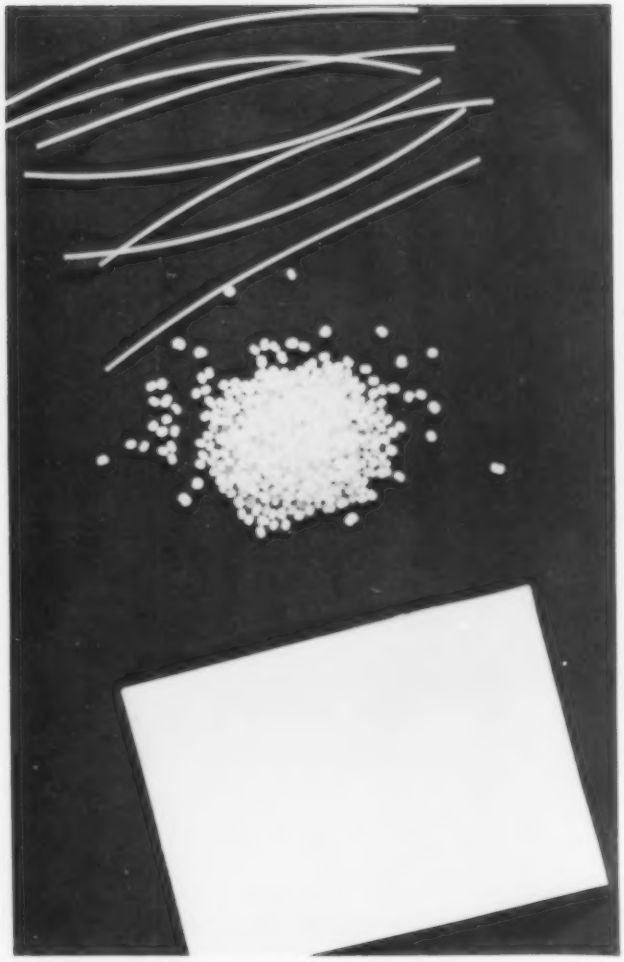
NBS researchers are proposing the use of a polyethylene Standard Reference Material as a nationally accepted control in the testing of candidate biomedical implant materials.

Anthony J. Bur, Polymers Division, A148 Polymers Building, 301/921-3336.

The testing of candidate biomedical implant materials to ascertain their biocompatibility involves the implantation of these materials in animals and the subsequent observation of the tissue reaction to their presence. Some of the variables in such tests, difficult to control on a national scale, are quality, species, and diet of the animals which are used. To circumvent this problem, a technique used in toxicity tests involves implanting a "negative control material" along with the material under test. The tissue reaction is then recorded as the ratio of its reaction to the test material versus its reaction to the negative control.

Since there exists no nationally accepted control for polymer implants, we have proposed that polyethylene fabricated from Standard Reference Material 1475 or 1476 be considered. To test this proposal, we are working with Drexel University to fabricate the pellet SRM material into sheet and rod shapes. Since the surface of these samples will be the reactive interface with the tissue, surface uniformity is essential. Contact angle and infrared absorption are being used to monitor the surface. Other characterization, such as density and trace element analysis, is also being carried out.

Samples will be evaluated as control specimens by a laboratory developing toxicity test methods for the Food and Drug Administration and may be used later in an American Society for Testing and Materials round-robin test protocol.



Polyethylene pellets (center of photo) are fabricated into sheets (15 cm x 15 cm x 0.5 mm) and rods (15 cm x 1.5 mm diameter) for biocompatibility testing.

REFERENCE DATA REPORT: NEW FORMAT FOR NSRDS NEWSLETTER

The Office of Standard Reference Data (OSRD) has produced the first issue of Reference Data Report, *replacing* NSRDS News, *which has served as the NSRDS newsletter since 1966.*

Sherman P. Fivozinsky, Office of Standard Reference Data, Room A537 Administration Building, 301/921-2104.

The new format has been established to provide a more effective informal communication medium for the National Standard Reference Data System. The publication will include short articles of interest to data producers, evaluators, and users. Subject matter will emphasize new and interesting activities in NSRDS data centers as well as information of general interest in the science and technology community. In addition, there will be guest editorials, news briefs, OSRD activities, and announcements of new publications. The newsletter will be published bimonthly by the Office of Standard Reference Data.

CONFERENCES

For general information on NBS conferences, contact Sara Torrence, NBS Office of Information Activities, Washington, D.C. 20234, 301/921-2721.

TELECOMMUNICATIONS TECHNOLOGY AND LIBRARIES CONFERENCE

New advances in Telecommunications Technology and their effect on libraries and information systems will be the topic of a special one-day conference on Friday, June 3, 1977.

The Telecommunication Technologies, Networking, and Libraries Conference will address such subjects as teleconferencing, satellite transmission of data, slow-scan (telephone transmission) TV, and videodiscs—technologies which are expected to cause radical changes in the ways in which libraries and information centers receive, store, and communicate information.

The conference will also feature a "pro and con" discussion of the controversial Consumer Communications Reform Act, which would require the Federal Communications Commission to deny a license to any specialized interstate communication carrier that proposes to furnish a service similar to any service provided by an existing telephone or telegraph service.

Among the guest speakers featured at the conference will be:

- Henriette Avram, Special Assistant for Networking Development at the Library of Congress, speaking on the National Bibliographic Telecommunications Network;
- Dr. Thomas Belden, Crisis Advisor to the Director of Central Intelligence, speaking on the "Uses of Teleconferencing in Crisis and Warning Situations";
- John Little, Coordinator of the National Commission on Libraries and Information Systems—National Bureau of Standards Task Force on Computer-to-Computer Protocols, speaking on the development of protocols for linking computer networks;
- Earl Henderson of the Lister Hill National Center for Biomedical Communications, on the use of satellite communications;
- Alan Stricklin of I/O Metrics Corporation, speaking on the use of videodiscs for information storage and training; and
- Dr. Richard Lee of the National Science Foundation, who will discuss support for library telecommunications research and development programs.

The registration fee for the conference is $30, covering attendance, lunch, and a copy of the printed proceedings. Those interested in attending the conference should contact: Patricia W. Berger, Chief, Library Division, E120 Administration Building, 301/921-3405.

ACM/NBS SYSTEMS AND SOFTWARE SYMPOSIUM

"Systems and Software: Operational Reliability and Performance Assurance" will be the theme of the 16th annual technical symposium of the Association for Computing Machinery (ACM) and the National Bureau of Standards' Institute for Computer Sciences and Technology. The symposium will take place at the Bureau's Gaithersburg, Maryland, headquarters on June 2, 1977.

In the keynote address, Major General Jack L. Hancock, Commanding General, U.S. Army Computer Systems Command, will discuss "Software and the User: Requirements, Reliability, and Maintenance."

The symposium will feature a special session on software management issues. The session chairperson, Barry C. DeRoze, Office of the Secretary of Defense (Installation and Logistics), will speak on software management within the Department of Defense.

At the same session, William Franklin of the Office of the Secretary of Defense (Comptroller) will speak on personnel development and training issues of software management. Dr. Tom Sleight of the Johns Hopkins Applied Physics Laboratory will deal with theory and practice in requirements, validation, and analysis.

Other sessions, addressing operational reliability and performance assurance issues in systems and software areas, will include:

- Audit and Evaluation of Computer Security—

Session to be chaired by Robert McKenzie, General Accounting Office.

Highlights of a National Bureau of Standards Workshop on Audit and Evaluation of Computer Security, March 22-24, 1977, will be presented by:

Robert H. Courtney, Jr., System Research Institute, IBM

Harry Robinson, Vice President, Metropolitan Life Insurance Co.

Dr. Carl Hammer, Director, Computer Sciences, Sperry UNIVAC Computer Systems

Leonard Krauss, Manager, Management Consulting Services, Ernst and Ernst

Following the presentation, speakers will join Mr. McKenzie for a panel discussion.

- Software Management—

Session to be chaired by Major Walter Figel, Defense Communications Agency.

- Data Management: Performance and Reliability Issues—

Session to be chaired by Ms. Carol Peters, Ocean Data Systems, Inc.

- Performance Measurement and Evaluation and Software Testing—

Session to be co-chaired by Arthur F. Chantker, Federal Aviation Administration, and Jim Elliott, MITRE Corp.

- Microprocessor Applications—

Session to be chaired by Prof. Arnold Meltzer, George Washington University

- Graphics-Aided Management—

Session to be chaired by Ms. Jackie Potts, Social Security Administration.

Serving as symposium chairman is Dr. David Wood, the MITRE Corporation, 1820 Dolley Madison Boulevard, McLean, VA 21101; phone 703/790-6394.

For further information contact:

Program Chairperson is Dr. Stuart Katzke, National Bureau of Standards, A265 Technology, Washington, D.C. 20234; phone 301/921-3861. For registration information, write or call Thomas L. Hahler, 7225 Timber Lane, Falls Church, VA 22040; phone 703/790-3548.

CONFERENCE CALENDAR

May 10-12

SEVENTH SYMPOSIUM ON THERMOPHYSICAL PROPERTIES, NBS, Gaithersburg, MD; sponsored by NBS and the American Society of Mechanical Engineers; contact: Ared Cezariliyan, Room 124, Hazard Building, 301/921-3687.

May 16-18

CONFERENCE ON CORROSION OF METAL IN BUILDINGS, NBS, Gaithersburg, MD; sponsored by NBS; contact: Dr. G. Frohnsdorff, B350 Building Research Building, 301/921-3458 or Dr. J. Kruger, B252 Materials Building, 301/921-2094.

May 17-19

MECHANICAL FAILURES PREVENTION GROUP, Illionis Institute of Technology Research Institute, Chicago, Ill., sponsored by NBS, MFPG and IITRI; contact: Harry Burnett, B260 Materials Building, 301/921-2813.

May 19

TRENDS AND APPLICATIONS SYMPOSIUM COMPUTER SECURITY AND INTEGRITY, NBS, Gaithersburg, MD; sponsored by NBS, and IEEE Computer Society; contact: Marshall Abrams, B212 Technology Building, 301/921-2601.

June 2

SYSTEMS AND SOFTWARE: OPERATIONAL RELIABILITY AND PERFORMANCE ASSURANCE; 16th Annual Technical Symposium, NBS, Gaithersburg, MD; sponsored by the Association for Computing Machinery, Washington, D.C. chapter, and NBS. Contact: Stuart Katzke, A265 Technology Building, 301/921-3861.

June 3

TELECOMMUNICATIONS TECHNOLOGIES, NETWORKING AND LIBRARIES, NBS, Gaithersburg, MD; sponsored by NBS; contact: Patricia Berger, E120 Administration Building, 301/921-3405.

June 8-9

ULTRAVIOLET WORKSHOP, NBS, Gaithersburg, MD; sponsored by NBS; contact: Jack Tech, B308 Metrology Building, 301/921-3864.

June 13-15

CONFERENCE ON ULTRASONIC TISSUE CHARACTERIZATION, NBS, Gaithersburg, MD; sponsored by NBS; contact: Melvin Linzer, A329 Materials Building, 301/921-2858.

August 9-11 CANCELLED

FIFTH SYMPOSIUM ON THE SIMULATION OF COMPUTER SYSTEMS, NBS, Gaithersburg, MD; sponsored by NBS and the Special Interest Group on Simulation of the Association for Computing Machinery; contact: Paul Roth, B250, Technology Building, 301/921-3545.

September 7-8

SEMINAR ON EARTHQUAKE DESIGN CRITERIA, STRUCTURAL PERFORMANCE, AND STRONG MOTION RECORDS, NBS, Gaithersburg, MD; sponsored by NBS, EERI; contact: Dr. Richard Wright, B244 Building Research Building, 301/921-3377.

September 21-23

SYMPOSIUM ON ROOFING TECHNOLOGY, NBS, Gaithersburg, MD; sponsored by NBS and the National Roofing Contractors Association; contact: Robert G. Mathey, B348, Building Research, 301/921-3407.

September 28-30

DATA ELEMENT MANAGEMENT SYMPOSIUM, NBS, Gaithersburg, MD; sponsored by NBS and ANSI Committee X3L8; contact: Hazel McEwen, B226 Technology Building, 301/921-3157.

October 3-6

ALTERNATIVES FOR CADMIUM ELECTROPLATING IN METAL FINISHING, NBS, Gaithersburg, MD; sponsored by NBS, Consumer Product Safety Commission, Department of Defense, Department of Interior, Occupational Safety and Health Administration, Environmental Protection Agency, Food and Drug Administration, and General Services Administration; contact: Fielding, Ogburn, B166 Polymers Building, 301/921-2957.

October 11-13

MATERIALS FOR COAL CONVERSION AND UTILIZATION, NBS, Gaithersburg, MD; sponsored by NBS, Energy Research and Development Administration, Electric Power Research Institute; contact: S. J. Schneider, B303, Materials Building, 301/921-2893.

October 11-14

COMPUTER PERFORMANCE EVALUATION USERS GROUP, 13TH MEETING, New Orleans, LA., sponsored by NBS; contact: Dennis Conti, A248 Technology Building, 301/921-3861.

November 1-3

MECHANICAL FAILURES PREVENTION GROUP, NBS, Gaithersburg, MD; sponsored by NBS and MFPG; contact: Harry C. Burnett, B260 Materials Building, 301/921-2818.

November 13-17

WORKSHOP ON RAPID SOLIDIFICATION TECHNOLOGY, Sheraton-Reston, Reston, VA; sponsored by NBS, ARPA; contact: Dr. Arthur Ruff, B264 Materials Building, 301/921-2811.

December 5-7

WINTER SIMULATION CONFERENCE, NBS, Gaithersburg, MD; sponsored by NBS, the Association for Computing Machinery, the Institute of Electrical and Electronic Engineers, Operations Research Association of America, the Institute for Industrial Engineers, and the Society for Computer Simulation; contact: Paul F. Roth, B250 Technology Building, 301/921-3545.

PUBLICATIONS

NEW SRM PRICE LIST AVAILABLE FROM NBS

Catalog of NBS Standard Reference Materials (Supersedes NBS Special Publication 260-1973 Edition), National Bureau of Standards (U.S.) Special Publication 260-1975-76, 90 pages (June 1975) SD Catalog No. C13.10:260-1975-76, $1.50.

The 1977 price list of Standard Reference Materials (SRM's) offered by the National Bureau of Standards' Office of Standard Reference Materials is now available.

This list supplements the 1975-76 *Catalog of Standard Reference Materials* (NBS Special Publication 260). It lists in detail 80 new SRM's which have been prepared since that edition and includes all 950 SRM's now available. SRM's have been added in such categories as forensic science, environment, industrial hygiene, thermal expansion, polymers, and magnetic tapes.

The new price list also includes information on revised certificates and SRM's that have been discontinued or are out of stock.

The 1977 price list may be obtained free by writing the Office of Standard Reference Materials, National Bureau of Standards, Washington, D.C. 20234 or by calling 301/921-2045. A very limited supply of NBS Special Publication 260, *Catalog of NBS Standard Reference Materials,* is available from the Office of Standard Reference Materials.

IS HYDROGEN SAFE?

Is Hydrogen Safe?, Hord, J., Nat. Bur. Stand. (U.S.), Tech. Note 690, 38 pages (Oct. 1976) SD Catalog No. C13.46:690, 85 cents.

Can hydrogen be safely stored and used as a commercial fuel? The answer is a qualified "Yes" according to a new publication of the National Bureau of Standards.

Hydrogen, because it burns cleanly and is quickly returned to the environment, has often been proposed as a good synthetic fuel to take the place of less abundant fuels such as gasoline or natural gas. One of its major drawbacks is its reputation as an explosive that was firmly fixed in the public mind by the Hindenburg disaster in 1937.

Is Hydrogen Safe? by Jesse Hord of the NBS Cryogenic Division is a systematic examination of hydrogen as a safety hazard as compared to gasoline and methane, the major component of natural gas. Hord's conclusion is that all three fuels can be safely stored and used, but that the amount of risk for each fuel depends on the particular application, and should be tested in advance.

Although one problem with the introduction of hydrogen as a fuel is that it would present users with a set of new and unfamiliar hazards, Hord finds that though the three fuels have different characteristics, no one is preferable to the other two. The danger of a fuel-air explosion when the fuel is released in a confined space is greatest for hydrogen, but, notes Hord, there are a number of preventive measures that can significantly reduce the danger of explosion for all three fuels.

Based on a review of over 80 published sources and some unpublished research, *Is Hydrogen Safe?* examines the hazards and possible damage caused by fire or explosion of all three fuels, compares storage methods, and discusses some possible uses for hydrogen.

Hydrogen has been successfully used in some industries for years, though not always as a fuel, and can in theory be used to fuel ships, planes, trucks, buses, trains, and automobiles. Home appliances and furnaces can also be made to run on hydrogen gas, and, in fact, hydrogen-enriched gases have successfully been used in Europe as residential fuels.

In addition to a table comparing 63 physical properties of hydrogen, methane, and gasoline, Hord's work provides a useful bibliography of federal and private guidelines for the safe storage and handling of hydrogen, and a reference index of mandatory federal regulations on the transportation of hydrogen as a gas or liquid.

THERMOPHYSICAL PROPERTIES DATA PUBLISHED

The Thermophysical Properties of Methane, from 90 to 500 K at Pressures to 700 Bar, Goodwin, R. D., Nat. Bur. Stand. (U.S.), Tech. Note 653, 280 pages (Apr. 1974), SD Catalog No. C13.46:653, $2.
Thermophysical Properties of Ethane, from 90 to 600 K at Pressures to 700 Bar, Goodwin, R. D., Roder, H. M., and Straty, G. C., Nat. Bur. Stand. (U.S.), Tech. Note 684, 326 pages (Aug. 1976), SD Catalog No. C13.46:684, $3.85.

The most accurate and comprehensive collection of data for the properties of ethane has been completed and published as NBS Tech. Note 684 by the National Bureau of Standards Cryogenics Division, Boulder, Colo.

Ethane is a colorless, odorless, gaseous hydrocarbon fuel primarily found in natural gas. The accurate knowledge of compressed and liquefied ethane property values are essential for the processes of liquefaction, separation, storage, pumping, transportation, and equitable trade of hydrocarbon gases containing ethane.

Authored by R. D. Goodwin, H. M. Roder and G. C. Straty and titled, "Thermophysical Properties of Ethane, from 90 to 600 K at Pressures to 700 Bar," the 326 page publication includes data on melting pressures, orthobaric liquid densities, PVT (pressure-volume-temperature) properties, specific heats, acoustic properties, and derived thermodynamic properties. The publication also contains the first available thermodynamic function tables for liquid ethane below its normal boiling temperature (184.5 K).

The commercial value of LNG (liquefied natural gas) depends on its heating value; thus, the densities of LNG mixtures and

other requisite properties are important data for calculating the liquid's energy content. Research on the pure components of LNG type mixtures began at NBS in 1970. Since 1970, NBS has developed a rational equation of state boundary and gives a qualitatively correct behavior for derived specific heats. This equation was first used in the NBS data report on compressed and liquefied methane.

The published ethane data in NBS Tech. Note 684 will aid in the production of ethylene, assist in the domestic and international trade of LNG, and enhance the safety and efficiency of engineering plant design.

PUBLICATIONS

Analytical Chemistry

Buffone, G. J., Standardization of Light Scattering Measurement in Conjunction with Immunochemical Analysis, J. Res. Nat. Bur. Stand. (U.S.), 80A (Phys. and Chem.), No. 4, 605-608 (July-Aug. 1976).

Burke, R. W., and Mavrodineanu, R., *Acidic Potassium Dichromate Solutions as Ultraviolet Absorbance Standards, J. Res.* Nat. Bur. Stand. (U.S.), 80A (Phys. and Chem.), No 4, 631-636 (July-Aug. 1976).

Atomic and Molecular Studies

Argentar, H., *Structure- and Solvent-Property Relationships for the Electronic Energies of Charge-Transfer Complexes Between Certain Benzene Derivatives, J. Res.* Nat. Bur. Stand. (U.S.), 80A (Phys. and Chem.), No. 2, 173-187 (Mar.-Apr. 1976).

Bass, A. M., Ledford, A. E., Jr., and Laufer, A. H., *Extinction Coefficients of NO_3 and N_2O_4, J. Res.* Nat. Bur. Stand. (U.S.), 80A (Phys. and Chem.), No. 2, 143-166 (Mar.-Apr. 1976).

Birks, J. B., *Fluorescence Quantum Yield Measurements, J. Res.* Nat. Bur. Stand. (U.S.), 80A (Phys. and Chem. No. 3, 389-399 (May-June 1976).

Callis, J. B., *The Calorimetric Detection of Excited States, J. Res.* Nat. Bur. Stand. (U.S.), 80A (Phys. and Chem.), No. 3, 413-419 (May-June 1976).

Corliss, C. H., *Oscillator Strengths for Lines of Ionized Uranium (UIII), J. Res.* Nat. Bur. Stand. (U.S.), 80A (Phys. and Chem.), No. 3, 429-438 (May-June 1976).

Health and Safety

Weisman, I. D., Bennett, L. H., Maxwell, L. R., Sr., and Henson, D. E., *Cancer Detection by NMR in the Living Animal, J. Res.* Nat. Bur. Stand. (U.S.), 80A (Phys. and Chem.), No. 3, 439-450 (May-June 1976).

Electromagnetic Metrology

Kerns, D. M., *Plane-Wave Scattering-Matrix Theory of Antennas and Antenna-Antenna Interactions: Formulation and Applications, J. Res.* Nat. Bur. Stand. (U.S.), 80B (Math. Sci.) No. 1, 5-5 (Jan.-Mar. 1976).

Glasser, M. L., *Definite Integrals of the Complete Elliptic Integral K, J. Res.* Nat. Bur. Stand. (U.S.), 80B (Math. Sci.), No. 2, 313-323 (Apr.-June 1976).

Golberg, K., Leighton, F. T., Newman, M., and Zuckerman, S. L., *Tables of Binomial Coefficients and Stirling Numbers, J. Res.* Nat. Bur. Stand. (U.S.), 80B (Math. Sci.), No. 1, 99-171 (Jan.-Mar. 1976).

Johnson, C. R., *A Note on Paris of Matrices With Product Zero, J. Res.* Nat. Bur. Stand. (U.S.), 80B (Math. Sci.), No. 3, 333-335 (July-Sept. 1976).

Katz, I. N., and Cooper, L., *Optimal Facility Location for Normally and Exponentially Distributed Points, J. Res.* Nat. Bur. Stand. (U.S.), 80B (Math. Sci.), No 1, 53-73 (Jan.-Mar. 1976).

Merris, R., *The Kronecker Power of a Permutation, J. Res.* Nat. Bur. Stand. (U.S.), 80B (Math. Sci.), No. 2, 265-268 (Apr.-June 1976).

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NEWS BRIEFS

SECURE HANDLING OF AUTOMATED MESSAGES. As several defense agencies proceed with automation of their message systems, the NBS Institute for Computer Sciences and Technology (ICST) is chairing a technical review committee looking into security safeguards applicable to the preparation, approval, and release of formal messages. The committee, established by the Advanced Research Projects Agency (ARPA), will deal with the complications of security under circumstances where the classification of the information handled is constantly changing.

FREE PAMPHLET ON HOME SECURITY ALARM SYSTEMS. With the increasing rate of residential burglary, many homeowners want the additional protection offered by a security alarm system. Descriptions of the different systems and their operation are highlighted in a new pamphlet--Home Security Alarms: What They are and How They Work--just published by NBS. For a free copy, write: "Home Security Alarms," Consumer Information Center, Pueblo, Colo. 81009.

SYMPOSIUM FEATURES ULTRASOUND AS MEDICAL TOOL. The use of ultrasound as a medical tool will be discussed June 13 to 15 at the Second International Symposium on Ultrasonic Tissue Characterization at NBS in Gaithersburg, Md. One highlight will be a panel discussion by experts on the use of ultrasonic diagnosis as an alternative to potentially risky x-ray screening for breast cancer. In many cases, ultrasonic signals, created by the passage and reflection of sound waves through the tissue, can provide more information about tissue conditions than x-rays, and without some of the damaging side effects that x-rays may exhibit. The symposium is cosponsored by NBS, the National Institutes of Health, and the National Science Foundation.

WINDOWS PROVIDE MORE THAN A VIEW. An NBS publication now in press shows that windows can be put to work to help conserve energy. Window Design Strategies to Conserve Energy (Building Science Series 104) evaluates the energy and nonenergy advantages and disadvantages of 33 possible window design strategies. The publication is intended for professional designers, lessees and owners of commercial space, home buyers and owners, window component manufacturers, and researchers.

TEST WALL IS MOVED FROM OLD NBS SITE. A unique stone exposure test wall that stood at the Bureau's old site in the District of Columbia for 30 years has been moved to NBS' current headquarters in Gaithersburg, Md., to save it from demolition. The 11.6 m-long, 4 m-high structure, which contains over 2300 samples of building stones, required a special hauling apparatus and had to travel between midnight and 5 a.m. to avoid clogging traffic on busy streets. The wall is used to test the natural weathering of building materials.

NEXT MONTH IN

DIMENSIONS/NBS

What's in store for Americans in the move to metric? An Australian official relates some of his nation's experiences in metrication and offers some insight and advice in the June issue of DIMENSIONS/NBS

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